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Life, Health and Nutrition
By J. F. Wischhusen, Inorganic Biochemicals, Cleveland, Ohio.

•

Billions for Cosmetics
By Irving Ebling and Donald L. Gibson, Pittsburgh Section, American Chemical Society.

The Problem of Living with 10,000,000 Deer

• By **Floyd B. Chapman, Ph.D.,** *(Ohio State University)*
ASSOCIATE CHIEF, GAME MANAGEMENT, OHIO DIVISION OF WILDLIFE, COLUMBUS, OHIO

The problem of assuring the survival of our deer population, and preventing them from becoming a menace to the conservation of our forests, to farmers and motorists is very complex.

Public understanding of the importance and the difficulties involved is essential in establishing a program of sound deer management. Unfortunately, human sentiment has interfered with the establishment of such programs.

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At the beginning of the present century an estimated half million wild deer lived in the United States. Since then the population has virtually grown by leaps and bounds and present herds are believed to contain more than ten million animals, or about one deer to every sixteen people in the United States. It is indeed one of the miracles of conservation when hunters in forty-four states can now harvest more than one million deer annually without harm to a population that is still growing. It is all the more significant when one realizes that deer were virtually or completely exterminated from a number of these states shortly after the pioneer era closed.

The tremendous upsurge in deer populations since 1900 has come about in various ways, among them: protection by closed seasons, protection by means of refuges, live-trapping and transplanting to stock depleted range, relentless control of predatory animals which capture and feed on deer, and limiting hunting to the taking of male or buck deer only. Changing habitat conditions for deer also deserve special mention. Deer are usually considered forest game animals and most of their time is spent in forest and heavy brush. However, optimum populations are reached in the brushy or second-growth stages of forest succession, not in the mature or climax forests. The reason for this is that deer are "browsing" animals which feed on shrubs, tree seedlings and sprouts that thrive, not in the shade of a closed forest canopy but in full or partial sunlight. Harvesting a crop of sawlogs creates highly desirable food conditions for deer. The benefits persist during the long period of time required for the young woods to become mature again.

After the pioneering era came to a close in the United States, vigorous clearing of the forests in the East continued at an accelerated pace. Some of this land was prepared for farm crops, some became pasture, but a very great acreage was permitted to revert to forest again. It was during this period of succession to forest that deer, with protection and the other management techniques mentioned earlier, began to increase and spread. It was also at this time that Theodore Roosevelt and several contemporaries stirred peoples' imagination with their philosophy of forest conservation. National parks were established, forest preserves created, and extensive tree planting programs encouraged. No one foresaw any possible conflict between deer and forest conservation.

On the Kaibab Plateau of Arizona there were about 4000 mule deer in 1910. This herd was kept in check by white and Indian hunters, wolves, bobcats, coyotes and mountain lions. With the stroke of a pen, this famous north rim of the Grand Canyon became a game preserve. Deer hunting was stopped and paid hunters were sent in to destroy the predatory animals that had helped keep the deer herd in balance. By 1924 the Kaibab mule deer population had increased to 100,000 animals. During the two-year period that followed, sixty percent of them died from starvation. The mishandling of this deer herd was a national disgrace, but it brought into sharp focus for the first time the relationship between deer numbers and deer habitat. About this time there was coined the phrase "carrying capacity" which has come to mean so much to those animal ecologists whose job is to manage wildlife. A unit of range will support only a definite number of animals of a given species and no more, without serious deterioration of the habitat or catastrophe to the animals themselves.

One might think that a lesson had been learned from the Kaibab incident. Yet, more than thirty years later, at least fifteen states and provinces in the United States and Canada report starvation among white-tailed deer; starvation because not enough are harvested to keep the herds in balance with their range. In some cases the deer are under-harvested because of human sentiment. In other instances there are simply not enough deer hunters to harvest the surplus deer.

Where deer numbers have been permitted to get out of hand there has been serious damage to forest growth, new forest plantations, crops and orchards. Indeed, the ravenous appetites of deer have caused the virtual disappearance of certain plant species from local areas in several states. In several instances this has had a damaging influence on other forest dwelling animals such as the ruffed grouse, snowshoe hare and numerous smaller vertebrates.

Mr. Ernest Swift, former Conservation Director of Wisconsin once said, "If we in Wisconsin are to be expected to produce forests for the future; if we are to be expected to practice sound forest management and assure our wood-using industries of an adequate and continued supply of raw materials, we should immediately take steps to eliminate this greatest of stumbling blocks. And I use the word 'greatest' advisedly for the appetite of our huge deer herd has now assumed such proportions that it justifies such superlatives . . . fire will annually damage only one out of every 500 acres under protection . . . deer are each year crippling one out of every five acres!"

(Continued on Page 22)

The Romance of Tobacco Mosaic Virus and the Electron Microscope

• By **Robert V. Rice, Ph.D.,** *(University of Wisconsin)*
HEAD, DIVISION OF ELECTRON MICROSCOPY, DEPARTMENT OF RESEARCH IN CHEMICAL PHYSICS, MELLON INSTITUTE, PITTSBURGH, PA.

The tobacco mosaic virus, a readily available and easily purified virus, has been used by virologists in many basic studies.

This paper describes the contributions to our knowledge due to studies of tobacco mosaic primarily with the electron microscope, and other physical chemical instruments.

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The mosaic disease of tobacco plants has been known to science for about 100 years. Not until 1892, however, did Iwanowski first recognize that the damage to the leaves is caused by a very small particle which is now known as tobacco mosaic virus (TMV). In subsequent years most of the "big guns" of science have been trained on TMV. At first, plant pathologists and microbiologists had the "filterable virus", as it was called, all to themselves. It was interesting because the agent would pass through filters which were known to hold back all bacteria. By innoculating various kinds of tobacco plants and other plants with the filtrate containing TMV, the plant pathologists soon found many mutants or strains of the virus. They identified the strains by the different types of lesions or damaged spots produced by the disease on the leaves of plants. At present over one hundred such strains of TMV are known. In all this work living cells were found necessary for the reproduction of the virus. To this day no virus has ever been grown on a synthetic medium—that is, a solution containing no cells but only chemicals.

Biochemists soon started to isolate and purify the agent causing the disease. This work went on during the 1920's and 1930's and culminated with the crystallization of TMV in 1935 by Dr. Wendell Stanley who subsequently received the Nobel prize primarily for this brilliant achievement. Before the crystallization and even for sometime afterwards it was popular pseudo-scientific sport to philosophize as to whether viruses were alive or merely chemicals. Today most virus researchers consider these agents as on the borderline—sort of transition entities—between inert and living matter. As soon as the virus was obtainable in a purified form its composition was established as 6% ribonucleic acid and 94% protein. Differences in amino acid content of the protein were later noted between strains of TMV, and differences in composition of the nucleic acid have been found between TMV and similar plant viruses.

The ultracentrifuge was early (1933) used both to purify and analyze TMV as to size and shape. The rate at which a virus particle in solution will move in centrifugal fields (about 25,000 to 100,000 times gravity) depends, among other things, on its size and shape. The rate at which a particle in solution will diffuse depends also on its size and shape. By combining results of separate experiments on velocity centrifugation and diffusion of TMV solutions a value for the size and shape was obtained. A typical value was 12.3 $m\mu$ in diameter and 430 $m\mu$ long. Results of viscosity studies can also be combined with centrifugation; when these were applied to TMV, the results indicated a long narrow particle. TMV was also studied by optical techniques such as stream double refraction, electrical birefringence, and depolarization effects. All this work indicated the particle to be a long narrow one. Various other techniques such as passage of TMV through graded collodion membranes, x-ray

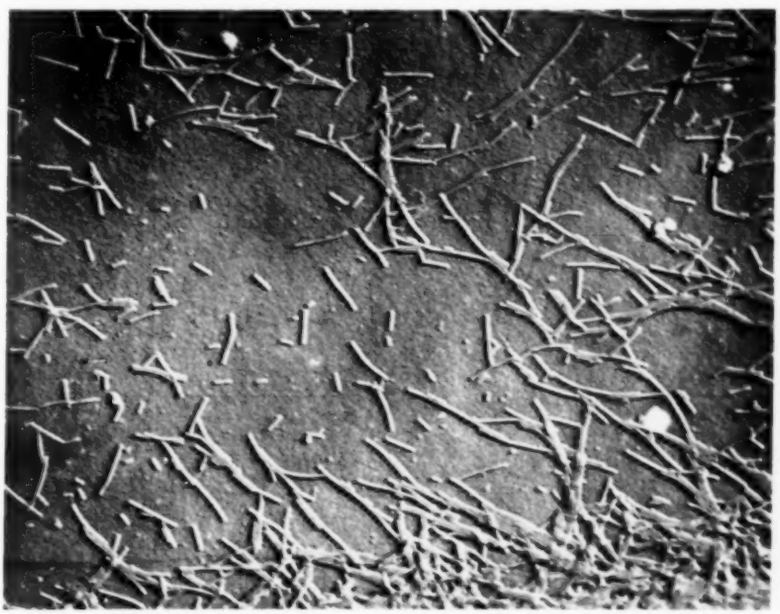

FIGURE 1. Electron micrograph of TMV particles showing the wide distribution of lengths usually found. This and subsequent electron micrographs show TMV shadowed with uranium at about a 4 to 1 angle. Magnification about 24,000X

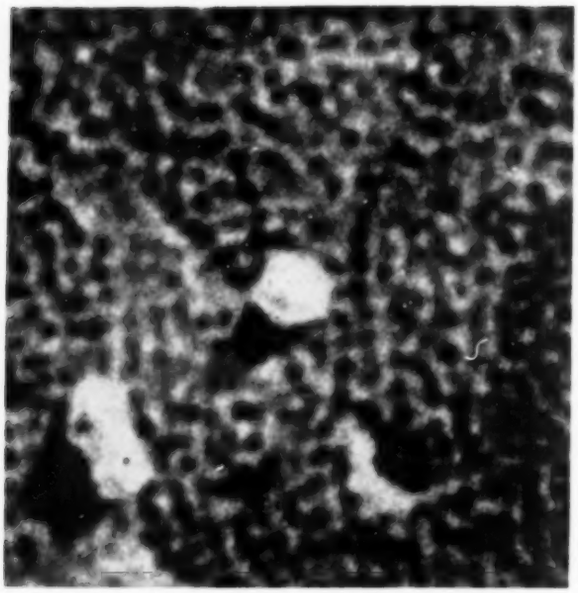

FIGURE 2. Electron micrograph of a piece of TMV broken by freeze-drying. The particle is approximately hexagonal suggesting that the TMV cross section is hexagonal. Magnification about 600,000X.

diffraction (which gave 15.2 m_μ for TMV diameters), and adsorption onto solid surfaces gave early workers the conception of TMV as a long narrow particle somewhere between 10 to 17 m_μ in diameter and from 120 to 700 m_μ long. The results of these hydrodynamic studies before 1938 are nicely summarized by Lauffer and Stanley.[1]

At about this time (1939) the electron microscope was being used to study biological materials and the first of a very large number of studies of TMV was published. The elongated shape of TMV was immediately evident, but for various reasons the identification of the basic infective particle with rods 15 m_μ wide and 300 m_μ long (as reported in the very first electron microscopical study) was not immediately agreed to by virologists. One of the reasons was the large variety of dimensions reported in the various hydrodynamic studies. The fact that particles under examination in the electron microscope are bone dry was also sufficient reason to question this identity.

A good description of the electron microscope and the methods of preparing specimens for examination appeared recently in an article by Dr. B. Siegel in THE SCIENCE COUNSELOR.[2] Since a beam of monochromatic electrons can exist only in a vacuum, all specimens must be dry. This means that the TMV particles are subjected to the tremendous force exerted by the surface tension of the drop of water as it dries. (The force can be as much as 300 tons per square inch for some biological particles.) This force tends to break up or flatten particles such as red blood cells and bacteria. In addition the process of isolating TMV may include freezing the leaves, grinding, and expressing the juice through coarse filters; it is reasonable to assume that such processes tend to break up the particles. All electron micrographs of TMV show particles of various lengths. (Fig. 1.) Old solutions usually contain more of the longer particles, and by incubating TMV solutions with enzymes or at certain pH values longer particles can be produced. Therefore, some virologists maintained the ultimate infectious particle to be shorter than 300 m_μ. They suggested that a very small particle might be the infectious agent and that the longer particles were aggregations. Many studies were made to find the infectious particle size. Correlations of infectivity with the results of electrophoresis and sedimentation indicated infectivity was associated with large elongated particles, but since no preparation of TMV had ever been examined which did not contain particles of all sizes, virologists could not be sure. An important experiment was devised by Williams and Steere using the spray droplet technique which was described in Dr. Seigel's article. They were able to show that TMV exists as a particle 298 ± 1 m_μ in solution. Later the same two researchers isolated the hexagonal inclusions of TMV found in epidermal cells of infected plants and showed that these inclusions

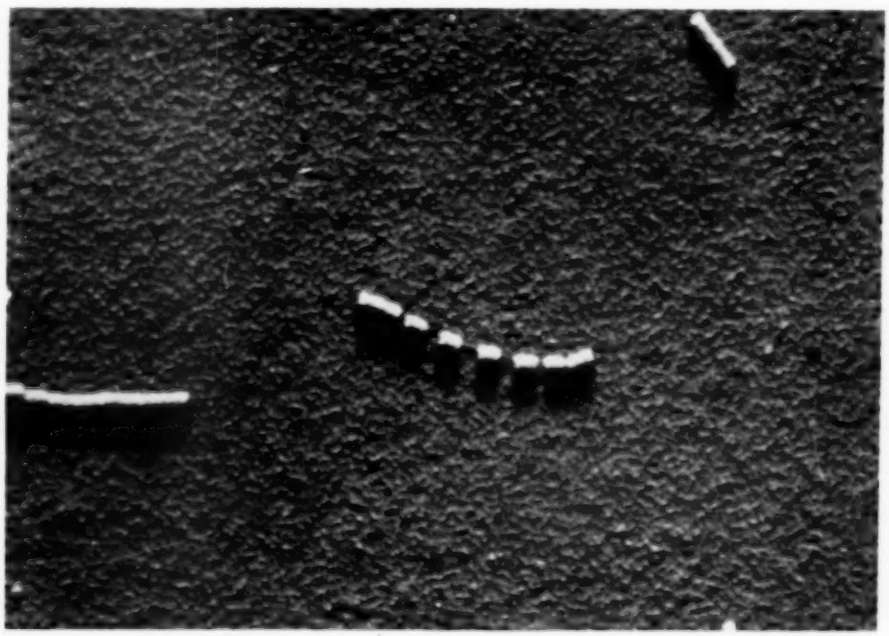

FIGURE 3. Electron micrograph of TMV broken by freeze drying. Nucleic acid strands can be seen between the broken pieces. Magnification about 70,000X.

consisted principally of 300-mμ rods. While it still remains to be shown that one 300-mμ rod will cause infection, the evidence is just short of overwhelming that the infectious agent is indeed a particle 300 mμ long and 15 mμ in diameter.

Although early x-ray diffraction studies of TMV indicated a hexagonal cross section most electron micrographs do not give much information about the short dimension of the particle. Many electron microscopists simply assumed a circular cross section as did the physical chemists working with the earlier hydrodynamic methods. However, by breaking up the TMV rod so that frequent "end on" views were obtained, three different groups have taken photographs showing approximately hexagonal platelets. Figure 2 shows a hexagonal cross section we found by examining small pieces of TMV broken by freeze drying. Because of the small size of the diameter there is still some uncertainty about the shape of the cross section of TMV.

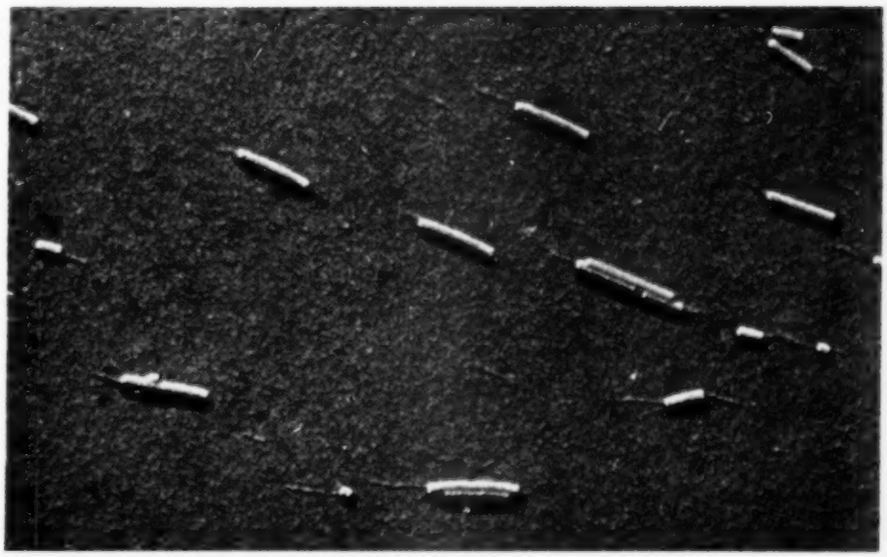

FIGURE 4. Electron micrograph of TMV treated with hot detergent to remove part of the protein sheath leaving a central core of ribonucleic acid. Magnification about 60,000X. Taken by Dr. R. G. Hart at the Virus Laboratory, University of California. Reprinted with permission of the University of Chicago Press from Proc. Nat. Acad. Sci., **41**, p. 262 (1955).

With the size and shape of TMV defined, electron microscopists have recently turned their attention to the structure of the particle. For ten years dimensions were studied, but inside of three years the gross structure has been established. Early work before refined electron microscopical techniques were available indicated that ribonucleic acid (RNA) might be either rather uniformly distributed throughout the particle or concentrated on the surface. TMV has been used as a test particle in the development of many new techniques. This use of TMV is the reason for the "Romance" part of the title of this article. It is a romance in the sense that scientists love to use it because of its size and shape and *availability*. Of all viruses it is most easily isolated in purified form in relatively large quantities (2 grams of TMV per liter of infectious plant juice). We used it in developing a freeze-drying method for preparing specimens for the electron microscope and soon found that under certain drying conditions TMV broke up into pieces which remained aligned so that their original arrangement in the whole rod was readily apparent (Fig. 3).[3] Between some pieces were indications of strands of material. It was of immediate interest to find out whether this material was the RNA. No electron-dense stains specific for either protein or nucleic acid are available as are stains for light microscopy. (The development of such stains is still in its infancy and is one of the most important research problems in the field.) We prepared relatively large amounts of TMV broken up in this manner and centrifuged them at various speeds. In the supernatant of these centrifugal solutions we found more ultraviolet absorption than in similarly centrifuged solutions of whole TMV. This observation indicated that the RNA, which absorbs at 260 mμ, was getting out of the particle, but it was only indirect evidence that the material between the breaks was RNA. A much more elegant approach was later used by Dr. Hart who treated whole TMV with an anionic detergent.[4] By this method the protein sheath was removed leaving a center strand of material (Fig. 4). The center strand was then removed (but not the remaining protein sheath) by incubating with ribonuclease, an enzyme specific for ribonucleic acid. Thus the gross structure of TMV is established as a rod 300 mμ long and 15 mμ in "diameter" having a central core of RNA about 3 to 4 mμ in diameter extending the length of the particle. There is some evidence from x-ray diffraction for external grooves along the TMV particle. This will be difficult to confirm by electron microscopy for the grooves may be only 2 mμ deep, but electron microscopists are already at work on this aspect of the structure.

For exciting the imagination of virologists nothing surpasses the recent work on degradation and recombination of TMV.[5] Workers in three different laboratories have been able to break up the TMV particle into long strands of RNA and small particles of protein. The two components were separated by ultracentrifugation; the protein alone proved not to be infectious and most infectivity experiments with RNA alone gave no evidence of viral activity. The two components were then combined in a buffer at pH 6 or 7 at 3° C. for 24 hours to form active virus particles. The electron microscope was used throughout these experiments to ascertain the appearance of the solution. Early in the "polymerization", disc shaped particles with central holes about

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Significant Advances in Graphic Arts Research

• By J. H. Winkler, B.S. in Chem. Engineering *(George Washington University)*
TECHNICAL ADVISOR, BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO

The development of industrial research institutes has been a major factor in the development of American technology. You will find much interesting and useful information in this discussion of research in the field of graphic arts.

This talk was given before the thirty-seventh Annual Convention of Printing House Craftsmen, Inc., August 13, 1956, in Los Angeles, California.

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Research Trends

Research is a word having many different meanings to many different people. As used here, it refers specifically to industrial research. It is surprising to most people to learn that research is not only one of the younger industrial functions, but that as a fully recognized procedure for corporate progress, it is just over fifteen years old.

In 1929, expenditures for research in this country amounted to only $160,000,000. This included industrial research, military research, university research, medical research, agricultural research, and all the physical and biological sciences. Even though we thought we were scientific-minded at that time and in the scientific era, research expenditures actually accounted for only 0.15 per cent of our gross national product. Even as late as 1940, total United States research accounted for the expenditure of only $345,000,000 per year. In 1954, in contrast, total research expenditures amounted to $3.75 billion or 1.25 per cent of our gross national product—more than 23 times as much dollarwise and nine times as much in relation to gross national product.

The use of the laboratory as a frontier for new industrial opportunities has resulted in what some writers call a "Technological Revolution." The beginning of this revolution was about 1940, when research "took over" as the primary basis for industrial expansion. The country's productivity kept right on going upward after World War II, along with the curve for research—the best evidence of the reality of a Technological Revolution.

Research remained highly individualistic long after formal research laboratories were organized. The idea of cooperative effort among scientists to expedite invention, discovery, and the solution of technical problems evolved gradually and painfully. Now, all modern laboratories mostly use teams of scientists in attacking problems, and such teams can accomplish in six months or a year what would take a lifetime of individual effort. This development of cooperative research has a tremendous effect on our industry and on our economic life. We can now compress into a few years the technological development that would otherwise have required decades. This fact makes scientific investigation of increased value to industry, since a company can reasonably expect to derive quick returns from its research investments.

More small companies are now actually engaged in scientific research than ever before. They accomplish this seemingly paradoxical feat by contracting with large central laboratories for research on their problems. They buy research services, just as they buy advertising or printing, and in so doing, are spared all the capitalization costs of a large, well-staffed laboratory. In effect, they put all or nearly all of their budget for research into its prosecution, thereby increasing the rate of their progress while at the same time avoiding heavy outlays for equipment and the maintenance of a staff.

There are three types of organizations that provide contract research services. These are commercial laboratories, research foundations associated with universities, and independent not-for-profit research institutes. In general, most of the problems studied by commercial laboratories are associated with a specific machine or product for a company while university research foundations do more work of a basic and theoretical nature. The independent not-for-profit research institutes offer services over a broad area of the sciences and technologies as applied to industrial operations.

The not-for-profit research institutes, although fewer in number, have reached a higher development in providing a general research service to industry. These organizations cover all fields of industrial science, and conduct both applied and fundamental research for industry. Most are substantially endowed or otherwise capitalized, and for their services they charge actual out-of-pocket expenses, plus a percentage to cover overhead and equipment depreciation. Research is conducted in confidence, and all results accrue to the company contracting for the work. In effect, then, these research institutes are the "private" laboratories of each of the thousands of companies they serve—providing confidential research at cost to the company, just as if the laboratory were a branch of the company. They serve both small and large companies alike, and, in addition, handle much of the contract research for governmental agencies.

Battelle is the largest of the not-for-profit independent research institutes, with about 2500 staff members and a physical plant having a replacement value well in excess of $20 million. Its current volume of contract research is at the rate of $20 million annually. In a typical year, it supplies research services to 1500 or more private companies, associations, or organizations.

Still another trend is aiding and abetting industrial progress. This is the rapidly developing public recognition of the value of science and the research function. The advertising profession, writers on scientific subjects,

the spokesman of industry, and others have done a good job of selling science to the general public. As a result, the public is becoming attuned emotionally and intellectually to the age in which we live and is developing increased faith in science and research, working through our own free enterprise system, to solve problems and provide a better life. You may recall that this was not true when most of us were youngsters. Then, the electric light was regarded with suspicion, and the early automobiles were subjects of public derision. Even such simple innovations as aluminum cooking ware had a hard time making the grade; the new metal would certainly poison her family, the housewife thought, and she had little faith in the aluminum industry's assurance to the contrary.

Graphic Arts Research

In the graphic arts industries, the activities of the International Association of Printing House Craftsmen, Inc., the Research and Engineering Council of the Graphic Arts Industry, Inc., and the Technical Association of the Graphic Arts have served to bring encouragement, recognition, and support to industrial research. Radically new processes and development such as phototypesetting, xerography, electronic engravers, and presensitized offset plates have found ready customers and enthusiasts. As a result, the research expenditures of the printing and publishing industries has continued at an estimated annual level of about $6,000,000 for the past five years. This is not a creditable total for an industry having a sales volume of over six billion dollars. It approximates about 0.1 per cent of gross sales. Compared to the dynamic research activities of some other industries, this is not nearly enough to achieve significant progress in the solution of the many formidable problems in the graphic arts. Once again it should be emphasized that one company, Time, Inc., is responsible for over one-fourth of the total printing industry research investment. Their research budget is reported to be in excess of one and one-half million dollars annually. The progressive management of Time, Inc., through their research policy have stimulated and encouraged graphic arts studies throughout our industries.

The subject matter and nature of research studies on graphic arts problems are not always published, particularly where a potential development of commercial value is involved. In general however, the printing and publishing industries have been generous in their reporting of research results. Some familiarity with the areas being studied can be obtained from the papers presented at the meetings of the Technical Association of the Graphic Arts and the reports given during meetings and conferences of the Research and Engineering Council of the Graphic Arts Industry.

In reviewing the topics for papers given during the last four meetings of TAGA, color separation and color correction has been the most popular subject. Eighteen papers pertaining to this area of interest have been presented. Other subjects receiving research attention and listed in the order of the number of papers devoted to the field are:

Ink, Ink Distribution, and Ink-Paper Relationships—10
Tonal Reproduction of Copy—9
Paper and Printability of Paper—7
Offset Lithographic Press Problems—7
Photosensitizers—6
Press Operations and Design—5
Offset Lithographic Plates—5

A total of about 100 papers were presented and about eighteen general subjects were covered in addition to the eight mentioned. Not all of these technical contributions are of immediate commercial value. Their publication does result in adding to our fund of knowledge about graphic arts processes, in technical recognition for the researchers, and in stimulating additional research effort.

The reports and talks given at the Research and Engineering Council meetings have been more applicable to commercial operations. These reports serve a valued objective in publicizing new developments and their potentialities. Within the past few years, subjects such as phototypesetting, letterpress printing plates, makeready and premakeready, and quality control have been treated intensively at their conferences and meetings. Many other important phases of the printing industries are also included in the activity scope of this splendid organization.

Illustrative Research Developments

The research investments in graphic arts have paid off generously and dramatically. The list of significant and practicable developments such as the Fotosetter and the Scan-A-Graver resulting from research efforts within the past ten years is an impressive one. A few of the recent developments will be briefly described to illustrate the value of research.

The Fotosetter machine is being used increasingly, and improved techniques for making corrections and performing make-up operations have been worked out. The Photon is now a successful commercial machine. It is being used in newspaper and trade composition shops. The Linofilm machine is now ready for field testing. Phototypesetting is here to stay and will increase in utilization and application. The recent Cold Composition Clinic of the Research and Engineering Council in Chicago on May 10 provided factual reports of experience with phototypesetting. The results reported during this meeting were surprising and enthusiastically optimistic.

The several photographic typesetting machines now available for setting headlines and captions have further expanded the field for cold composition. The Protype, Typro, Filmotype, Coxhead-Liner, and the Hadego machines offer a variety of flexibilities and operations. These machines exhibit ingenious solutions to former limitations in this area of copy preparation.

One of the most talked about developments in the printing field is the Eastman Short-Run Three-Color Offset Process. Some printers and platemakers have effectively applied the process in the creation of new markets for the reproduction of full-color transparen-

cies. The process is capable of some improvisation and modification, and this flexibility has opened many applications for three-color reproductions to the small printer as well as to the larger printing organizations. The Eastman Kodak Company recently reported a simple method of making a black from three color separations, so that four-color reproductions can be made with a minimum of facilities, time, and effort. This development is an important one and will find increased application.

The presensitized offset plate is now widely used in the lithographic industry. They are now available in a size as large as 40½ by 50 inches. They plan to produce them in even larger sizes. About a dozen kinds of paper and metal presensitized plates are now available for the office and small sizes of offset lithographic presses. The simplicity and ease of processing these plates are decided advantages.

The electronic engraving machine applications and developments continue to excite wide interest. Although the Scan-A-Sizer machine was announced over a year ago, it is not yet available commercially. About 2000 of the Scan-A-Graver machines are now in use, and the quality of work possible with these machines is continuing to improve. Of interest is the report that Mincel & Co., of Paris, has been appointed distributors of the Scan-A-Graver and Scan-A-Sizer equipment and materials in France by the Fairchild Camera and Instrument Co. In turn, the Fairchild people have received rights to the Mincel Luxographe machine, a French electronic engraver.

The Variable Density Control Device of the Fairchild Company was developed for use with the new Scan-A-Sizer. The machine makes possible an electronic tonal retouching of copy as the engraving is being made. The potentialities of this development are great. The principles are capable of adaptation to color separation and color correction and for use with or instead of a reproduction camera.

The utilization of various office reproduction and printing processes is a challenge to the ingenuity and judgment of graphic arts production executives. The competition of production facilities available in this field cannot be ignored. Recently a stenotype company in Cleveland purchased a Justowriter, a XeroX Copier, a Multilith machine, a small paper cutter, and a collating machine. The first job produced was a hard-bound book of 958 pages. A pleasing round was obtained by the trade-bindery in spite of the fact that the leaves were not stitched, but trimmed on the back edge and perfect bound. The sheets were run two pages up, side by side, and then backed up with two pages. Within three months, a second book of 360 pages was set and run by this company. This time the signatures were stitched and conventional edition binding used. The management of the company anticipates a continuing market for this kind of publication. New devices and processes for the office printing field are being introduced so rapidly that it is difficult to keep informed about them. Many of them should be considered for use by printing production executives.

In the photoengraving field, the most talked of developments are the high-speed one-bite powderless etching processes. Recently the development of improved sheet zinc for photoengraving has made possible the application of the Dow process to zinc. Originally developed for magnesium, conditions of operation have been developed so that the machines and principles of the Dow process can be applied also in etching zinc photoengravings. The Acme process is not as widely used as the Dow but is yielding satisfactory results according to reports. The major advantage of these etching processes is the elimination of side etching, or color loss, in making the plate. A great potential for thin-sheet wrap-around plates, utilizing photocomposing and step-and-repeat operations where needed, can still be realized through the perfection of these remarkable etching processes.

The Tenth International Congress of Master Process Engravers was held May 20-25, 1956, in Stresa, Italy, under the auspices of the Union Internationale de la Photogravure et de la Clicherie—Galvanotypie. Several interesting developments in the photoengraving field were reported. The Mathelec Process, developed in France is said to provide an improved method of etching zinc halftones. The process is claimed to obtain additional depth of etching without sidewall etching and maintains the tonal values present in the photoprinted image. The process is an electrolytic one employing a slightly alkaline solution and is controlled automatically in a specially designed machine. The solution can be used for etching over one thousand square feet of work before discarding.

The Elfers Process, an ingenious Dutch development, claims to effect an automatic tonal correction that eliminates handwork and re-etching. It may be used for making zinc or copper halftones. In this process the usual operations are followed through up to the staging operations. Instead of staging, a metal film is electroplated on the etched areas and in the depressions. Zinc is deposited on zinc plates, and when copper halftones are being made, copper is deposited on the etched plate. The presence and arrangement of the resist image results in a plated film that is nonuniform in thickness. The thickest deposits are formed in the shadow areas and the thinnest are in the highlight areas. The plating occurs only on the nonimage areas. The plating is continued until all of the hollows are filled and some of the metal actually covers the edges of the resist. The plate is then etched, and all of the electrodeposited metal is dissolved, and etching is continued into the base metal. Since the thinnest deposits are in the highlights, the etching of the base metal starts first in these areas. As etching progresses, successively darker tones are etched. When the deposited metal is dissolved from the shadows, the etching is stopped. This process is claimed to automatically achieve the desired tonal correction. By varying the thickness of the electrodeposited metal, tonal contrasts may be obtained as desired.

Another process reported from Holland is the Kroner Electrolytic Etching Solution for copper. The compo-

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Wildlife Conservation:
Training and Employment Opportunities

• By **Daniel L. Leedy, Ph.D.,** *(The Ohio State University)*
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Fish and wildlife, like agricultural crops, are renewable resources, and they are affected by man's use and abuse of the land.

Teachers, students and science counselors will find the information in this article to be both accurate and authentic.

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Conservation of the nation's natural resources is important to all of us; it's everybody's business! Of the many types of natural resources, let us consider fish and wildlife. These are renewable natural resources of much value and of interest to a great many Americans, including: (1) several thousand engaged in professional wildlife work; (2) some 25 million hunters and fishermen; (3) trappers, and those engaged in fur production, manufacture and trade; (4) those profiting financially from the sale of hunting and fishing opportunities, sporting goods, cameras, and binoculars; (5) those concerned in the many enterprises incidentally or indirectly connected with recreation and outdoor enjoyment; and (6) the many millions interested from the esthetic standpoint, deriving pleasure from observing wildlife species in their natural habitat. Also, under certain conditions, wildlife may be injurious to man's interests and then, rather than protect such animals, wildlife managers or control experts attempt to control them.

A recently completed nation-wide survey of expenditures of hunters and fishermen showed that nearly three billion dollars was spent on hunting and sport fishing in 1955. Commercial fishing is, of course, a big business in its own right and provides much high protein food. Muskrats, mink, beaver, and other fur animals furnish valuable pelts for the fur trade. The capture of such animals and sale of their pelts provide additional income to thousands of farmers and their sons during the fall and winter months.

Fish and wildlife, like agricultural crops, are products of the land and are affected by the way in which the land is used or abused by man. One of the chief differences between domestic crops and wildlife is that the wildlife resources belong to all the people and are held in trust for them by the State and/or Federal governments. Although the management of these resources falls to State and Federal conservation agencies, the landowners, who manage the land, control the wildlife habitat which, in turn, largely governs the presence or absence of wildlife. Government agencies set fish and game regulations to control the harvest of these resources; professional wildlife managers advise and assist with habitat improvement and other fish and game management programs; but, in the last analysis, the welfare of these resources largely depends on how the land is treated. If high school students, upon graduating and assuming their roles as citizens and voters, had a better knowledge of and appreciation for wildlife resources and their management, the future of fish and game for recreation would be more secure.

Much progress has been made during the past twenty years in developing training programs for college students who wish to become professional workers in wildlife conservation. Approximately fifty colleges and universities now offer fish and game management courses. However, the opportunities for inculcating on the minds of the much larger number of secondary school students some of the conservation concepts and principles, which would make of them better citizens, have been largely neglected. This is unfortunate because students at both the primary and secondary school levels are very receptive to conservation education, and as they grow up and take their places in adult society, they are in a position to promote or obstruct conservation programs. Teachers imbued with a progressive conservation philosophy are able to incorporate conservation into their teaching whether they are instructors in mathematics, grammar, history, government, earth science, or the biological sciences.

Teacher training courses that take the teachers to outdoor conservation laboratories where the relation of geology, soils, plants, animals, climatic influences, economics, and social forces are demonstrated by professionals in the field, are available in several states. The experience of living in camps and working in the out-of-doors under the guidance of recognized conservationists and university specialists in the various fields have been beneficial to many high school teachers who, in turn, have been better able to get across to their students the conservation concept. These conservation laboratories usually run concurrently with the summer school terms of the colleges or universities conducting such training programs, and the teachers or trainees receive college credit for their work. State Conservation Departments sometimes cooperate by providing personnel, quarters, or other facilities. Garden clubs, sportsmen clubs, or various other conservation groups frequently offer fellowships or make financial grants to encourage teachers to attend such training programs. Having attended one of these Conservation Laboratories many years ago as an assistant instructor working with a staff of specialists, and having been able to note the progress made by various trainees on their projects during a period of six or eight weeks, I can state with conviction that most of those enrolled learned much about

conservation and thoroughly enjoyed the time spent in camp. This type of training is cited only as one means teachers have of becoming better qualified to meet the needs for conservation education in public and parochial schools. Taking regular, on-campus courses is valuable also, as are travel, and reading of some of the now voluminous conservation literature.

Sources of Material for Teachers

Usually, teachers, even those in city schools, do not have to look far for examples of natural resource abuse—a muddy, silt-laden reservoir or river, or a gully in the school yard to illustrate erosion; fish and other aquatic forms, dead or dying as a result of pollution; and the use of trees and shrubbery in the school yard by birds and other animals may be observed to show the response to and dependence of animals on cover.

Teaching aids, pamphlets, books, and other materials useful in developing conservation programs are available from many sources, including the numerous conservation agencies—Federal, State, and private. *The Conservation Yearbook*, edited by Erle Kauffman and published yearly by Cornwell, Inc., 1025 Connecticut Avenue, N. W., Washington 6, D. C., would provide high school science teachers with a wealth of conservation information, including the names and addresses of most conservation agencies from which additional information may be obtained. The 304-page 1956 edition sold at $7.50 per copy. It would be a useful volume in the school library. The publisher's foreword to this edition contained the following descriptive paragraph:

> "Here in a single volume readers will find up-to-the-minute facts and figures in all fields—soil and water, forests and forest products, wildlife and fisheries, the range lands, parks and the wilderness. You will find a directory of more than 500 conservation organizations, in addition to the nation's 3,000 soil conservation districts, presented with essential facts about each district; you will find more than 5,000 names—key policy makers, legislators, planners, executives, managers, technicians, educators, editors, etc. In addition, you will find at your fingertips comprehensive coverage of the conservation estate—full roster of national parks, monuments, and forests, wildlife refuges and wilderness areas, of state parks and state forests".

The Directory of Organizations and Officials Concerned with the Protection of Wildlife and Other Natural Resources, although less inclusive, is a valuable directory and is available for forty cents from the National Wildlife Federation, 232 Carroll Street, N. W., Washington 12, D. C.

The National Wildlife Federation also distributes many pamphlets, booklets, and other materials that would be useful in high school conservation programs.

The Wildlife Management Institute, 709 Wire Building, Washington 5, D. C., a private, non-profit conservation organization devoted to promoting better use of natural resources, has among its important publications, the *Transactions of the Annual North American Wildlife Conference*. It sponsors wildlife research, assists with a nation-wide cooperative research and training program, issues a bi-weekly *Outdoor News Bulletin* and promotes conservation in other ways.

Names and addresses of many other national conservation organizations, such as the American Forestry Association, American Nature Association, Conservation Foundation, Izaak Walton League of America, National Audubon Society, National Parks Association, Nature Conservancy, Sport Fishing Institute, and Wilderness Society may be found in the conservation yearbook and the directory listed above. These organizations have a wealth of material for distribution that would be valuable to high school teachers interested in developing a conservation education program in their schools.

Among the national professional scientific organizations in the natural resources field are the American Fisheries Society, American Ornithologists' Union, American Society of Range Management, American Society of Mammalogists, Ecological Society of America, Soil Conservation Society of America and the Wildlife Society. Addresses of these societies also are available in the references listed above. These societies publish scientific journals containing a great deal of information on natural resources, their conservation and management. The Wildlife Society, in the July issue of its quarterly *Journal of Wildlife Management*, publishes the report of the Committee on Employment. This report gives useful information on the enrollment and the number of fish and wildlife students graduating from college, the percentage of graduates obtaining jobs and the outlook for future employment in the wildlife field. Many schools, in the interest of their career guidance service and their science library, subscribe to the *Journal of Wildlife Management*. Subscriptions are $6.00 annually, payable to the Wildlife Society, Office of the Executive Secretary, c/o U. S. Fish and Wildlife Service, Washington 25, D. C.

The Conservation Education Association's primary interest is to stimulate the development of sound education with respect to resource use. Its current Secretary-Treasurer is Mr. Wilson F. Clark, Eastern Montana College of Education, Billings, Montana. Members of this dues-paying organization develop and report on improved conservation education methods and programs in schools and state conservation departments throughout the country.

The National Association of Biology Teachers whose chief objective is to stimulate and assist in developing improved biology and conservation teaching in high schools and colleges has as its current Secretary, Mr. Paul Webster, Bryan High School, Bryan, Ohio. Its Conservation Chairman and Project Leader is Dr. Richard L. Weaver, School of Natural Resources, University of Michigan, Ann Arbor, Michigan. This Association, through its Conservation Committee, has prepared a *Handbook on Teaching Conservation and Resource-use*, a leaflet entitled *Criteria for Teaching Conservation in Biology* (free), a *Bibliography of Free and Inexpensive Material for Conservation Education* by Muriel Beuschlein (10 cents), and reprints of a

symposium on *Training the Conservation Worker* (10 cents). This symposium arranged by The National Association of Biology Teachers in cooperation with the American Institute of Biological Sciences contains abbreviated articles on training in the fields of forestry, wildlife management, fishery research and management, general conservation, and in the teaching of conservation. This material may be obtained from the Project Leader, Dr. Weaver, at the above address.

Among the Federal conservation agencies having information on natural resources which would be of value to high school teachers in their wildlife conservation programs are the Forest Service and the Soil Conservation Service in the U. S. Department of Agriculture, Washington, D. C.; and the National Park Service and the Fish and Wildlife Service of the U. S. Department of the Interior, Washington, 25, D. C. Requests for information may be addressed to the respective Offices of Information in these agencies. Among the material available from the U. S. Fish and Wildlife Service is Wildlife Leaflet 352, entitled "Wildlife Training and Employment". This lists more than fifty American colleges and universities which offer training in the wildlife field, gives some suggestions on preparing for wildlife work and comments on employment opportunities. Another Service leaflet, "Preparation for Positions in Fishery Research", presents information on training in that field.

The Federal Security Agency, Office of Education, Washington, D. C., also has publications that would be useful in high school conservation education programs. For example, Bulletin 1950, No. 15, "Better Living through Wise Use of Resources", by Helene Hatcher, has sections devoted to understanding our natural resources, significant conservation concepts, effective conservation materials and aids.

Most of the State Conservation Departments have publications, motion pictures, or other materials which would be of use in high school conservation programs; and an increasing number of colleges and universities, both state and private, have special conservation materials.

A recently published book, "Nature's Guardians—Your Career in Conservation", by Harry Edward Neal, Julian Messner, Inc., New York, 1956, pages 1-192, $3.50, undertakes to outline for people interested in employment possibilities in the natural resources field, various types of jobs that are available.

This book, like some of the other materials mentioned above, would be of value to teachers, students and science counselors alike in depicting various phases of conservation work. But despite the wealth of material available in published form, the most important asset a teacher can have for promoting conservation is a genuine and abiding interest in conservation. He must have knowledge, and an aptitude for conveying conservation information and concepts to his students, preferably by using everyday events and phenomena to illustrate the various principles.

Suggestions for High School Students Contemplating a Conservation Career

Wildlife conservation is a broad field and provides ever increasing opportunities for employment. Most of the people going into this field for their livelihood are biologists, law enforcement agents (officers), educators, or information-education specialists. Many employees are called upon to handle a variety of problems involving biology, law enforcement and conservation education, or public relations. In carrying out research and management programs, engineers are needed for constructing dams, roads, and buildings; chemists are needed to analyze food materials and to develop repellents or poisons for controlling animal pests; photographers and writers are needed for preparing reports and handling public relations work; statisticians are employed to evaluate data obtained on a variety of subjects; and other specialists are hired as required. A few people serve as wildlife consultants; others are finding jobs as conservation journalists or outdoor writers.

State conservation departments probably employ two-thirds or more of all people engaged in wildlife work. These employees are fairly evenly divided between the fisheries and the terrestrial wildlife fields.

Among the Federal agencies, the U. S. Fish and Wildlife Service employs the most personnel for wildlife conservation work, although the National Park Service, U. S. Forest Service, Soil Conservation Service, and other bureaus hire biologists and other workers. Of the college trained personnel going into the wildlife profession, a small percentage, usually those having a doctoral degree, become teachers of biology or conservation, primarily in colleges and universities. Some work for private agencies or go into business for themselves as consultants or fur farmers. Most of them, however, are technicians engaged either in research or wildlife management for conservation agencies.

For this reason, it would seem to be in order to mention here the type of training and qualifications considered desirable for people in professional career types of conservation jobs and to suggest how high school students interested in getting into such work may start their training before entering college. It should be made clear from the beginning that college training is now practically essential for professional wildlife employees and that for some positions, including college teaching a master's or doctoral degree is desirable or required.

In most positions, it is necessary for the wildlife employee to be able to work with people. Ability to meet people, and to speak and write effectively is highly important whether the employee is engaged in law enforcement, game management, research, or administration. It would be advisable, therefore, if high school students learned as much as possible about public speaking, composition, and report writing. Par-

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Health Enters by Way of Mouth

• By J. F. Wischhusen
CONSULTANT, INORGANIC BIOELEMENTS INC., CLEVELAND 10, OHIO

Modern methods of processing foods have resulted in the removal of essential nutrient elements from some of our most frequently used foods. The increased use of processed foods has made it necessary to study the demands of the body for carbohydrate, fat, protein, minerals, vitamins and enzymes.

This paper was presented before the twenty-third Annual Science Meeting, Randleigh Farm, Lockport, New York on September 22, 1956.

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Food Metabolism takes place according to the principles of biology:—an exact science. All exact sciences are governed by mathematical laws, as; for example those governing the physical sciences. But in the biological sciences the determination of such laws is still woefully inadequate; consequently, our concepts of what causes good or poor health will remain conjectural until biological laws, especially those governing food metabolism are understood.

Plants, animals, humans, will of course forever take their nutrients, directly or via each other with the aid of sunshine, from soil, air, and water according to biological laws whether anyone understands their mechanisms or not. Good health will result for each specie when all essential nutrients are constantly available to them in assimilable forms, and in correct and harmonious proportions. Vice versa poor or impaired health will inevitably result when the nutrients available for assimilation deviate from the optimum in numbers and concentrations.

Man in the past has absolved himself from responsibility for his own sickness, when as a matter of fact the responsibility is his personally. In the assimilation of nutrients plants are naturally governed by locality, and they take them up without regard for any food value for animals and man that may consume them. The idea of "health from the ground up" as far as humans are concerned cannot be taken for granted. When and where this is true, it is fortunate, but accidental and a good subject for analytical investigation. Plants as well as other forms of life are solely concerned with their own growth and propagation, and not at all mindful that they serve the purpose of food of ideal quality for the higher forms of life. Instead, it is logical for the higher forms to see and find their nutrients from various sources. Man, being omnivorous, and moreover in a position to acquire and apply scientific knowledge, is able to secure his nutrients from geologic, marine, plant, and animal sources. Anyone of them alone would be fragmentary and probably never result in optimal effects.

Tom D. Spies, M.D., a former Clevelander, now Professor and Head of the Dept. of Nutrition and Metabolism, Northwestern University, Chicago, Ill., several years ago told the American Medical Association at their 102nd annual meeting: "All disease is chemical and chemically correctible." He believes that cancer, high blood pressure, vascular lesions, and other disorders that commonly come with aging are directly connected with how people eat, assimilate, and utilize their food. "No one dies suddenly of heart disease or stroke, such persons have been chemically deficient for years," is what he told his audience of M. D.'s

Body chemistry is constantly varying, and neither disease organism nor host tissue is ever completely specific. The elements comprising the body are constantly engaged in a struggle for supremacy. Everyone harbors disease germs, yet not everyone is diseased. This is ascribed to "resistance" and suggests that germs are less important in disease than the chemical composition of the body. Since the elements that make up body composition come to us through the mouth from foods, it behooves each individual to ascertain whether he is selecting them correctly for the formation of a strong and healthy body, that is able to inhibit the growth of pathogens, repel parasites, avoid degeneration; or whether he eats foods for the composition of a body that attracts these pests and enables them to propagate, invade and injure the body, or cause lesions that cripple and impair its functions.

Our today's knowledge of foods covers five big groups of nutrients, viz: CARBOHYDRATES, PROTEINS, FATS, MINERALS (INORGANIC COMPOUNDS), AND AS ONE GROUP: MOISTURE, VITAMINS, ENZYMES, AND HORMONES. Carbohydrates and proteins are commonly consumed in the largest quantities, and because in their original raw state they combine most of the fats, minerals, vitamins as well as moisture, it will simplify the problem of the eater to study the composition of these two groups in terms of total essential nutrients. Then let him translate this knowledge into action by seeing to it that his total diet is representative of those nutrients.

Some nutrition authorities have divided the five big groups for good nutrition in about the following proportions, even though they are intermingled in natural food sources; viz:—

Carbohydrates	30%
Proteins	30%
Fats	20%
Minerals	5%
Moisture, Vitamins, Enzymes, Hormones	15%
	100%

This serves as a general guide which anyone can modify according to individual needs, but it must be remembered that each subdivision requires its own balanced composition.

Everyone who has studied mathematics, an exact science, or branches thereof such as: arithmetic, algebra, geometry, etc. knows the confusion and trouble that would arise from teaching or accepting that 2 by 2 equals 5, or 60 plus 50 equals 100. The consequences from faulty nutrition cause equally confusing and troublesome metabolic reactions, and may manifest themselves in the many and increasing numbers of so-called degenerative diseases and virus epidemics that baffle the medical professions. It is reported in the literature that the average modern American diet consists 60% of refined, concentrated, sterilized, *carbohydrates*. From them were deliberately removed the vitamins, minerals, enzymes that were originally present in the grains, vegetables, fruits, etc. from which the refined articles are obtained. Our dentists will most likely continue to be a very busy profession, because sound teeth cannot be formed when the tooth forming minerals are not present when tooth formation takes place. And tooth formation begins with the foetus. Osteoarthritis is another disorder that probably has its origin in a lack of bone forming elements when the skeleton is formed, and so are hare lips, cleft palates, and other skeletal shortcomings. All this because 60% of a group of refined nutrients are consumed where it is thought that only 30% should be present in total rations, or not more than 50% if in their raw, original, unrefined form. It can also be visualized that the addition of one tooth forming factor alone, such as fluorine, to the drinking water cannot overcome the existence of such complex deficiencies as are caused by refining bread and sugar for instance from whole grains and fruits. The quintessence of carbohydrates represents of course the elements carbon, hydrogen, and oxygen, and if health could be secured from their consumption in refined forms, alcohols and sugars would be sold under the heading of "Health Foods."

In regard to man's requirement of *proteins*, the problem of furnishing them adequately is somewhat easier than the problem of securing unsophisticated carbohydrates because proteins consist of amino acids of which about 22 are essential for good health. It can be shown by analysis whether they are present in the diet, and if not they can be furnished as supplements. *Fats* also are measurable for their nutritional value by the quantity and number of fatty acids that are contained in such sources as animal fats, vegetable and fish oils, butter and other sources. Some 23 different fatty acids have been isolated from the various crude sources, and they again differ in food values as to whether in an unsaturated or saturated condition. Unsaturated fatty acids have greater food value because of the presence in them of a so-called "double carbon bond," thus furnishing less hydrogen, but more carbon and oxygen as nutrients than the "saturated fatty" acids. All refined and processed fats and oils, call for suitable food supplements in the way of crude edible oils, lecithins, choline, inositol, and products high in unsaturated fatty acids (Wheat Germ Oil).

Minerals should be more correctly referred to as inorganic compounds, of definite specifications, because in their crude state they would represent rocks, asphalts, coals, and other raw materials that are out of the question as food sources. Apart from their essential nature in body structure minerals act as catalysts that facilitate biological reactions without necessarily entering into them and remaining part of them. For this purpose they must be constantly replenished, because they are constantly eliminated. The skeleton is also subject to constant formation and resorption, and represents an important reserve of some 18 different inorganic elements. Proteins cannot be formed from amino acids without calcium, sulphur, phosphorous, nitrogen. Hemoglobin of course represents a viable form of organic iron, insulin is a compound that centers around zinc, but neither of these molecules can be formed by the body without the aid of such catalysts as manganese, copper, cobalt, magnesium, etc. Iodine is necessary for thyroxine, the hormone produced by the thyroid gland. Minerals influence the contractility of muscles, and the irritability of nerves. They also control the liquids of the body. Digested foods for instance must readily pass from intestines into the blood stream without any blood passing back into the intestines. Minerals aid in the coagulation of the blood, to keep it neutral, to transport oxygen from lungs to tissues, and carbon dioxide from tissues to lungs. Because minerals enter into the composition of every living cell, they play essential roles in growth, reproduction and resistance to disease. Mental acuity in particular has been related to a group of Trace Elements such as manganese, copper, cobalt, iodine, zinc, magnesium, and also phosphorous. Bacteriacidal actions of metals have been demonstrated by many investigators.

Since all refined foodstuffs whether in the carbohydrate or protein group, have minerals as well as vitamins removed, a general supplementation of these to the average diet is called for. This is readily possible. In these supplements calcium and phosphorous should never be separated. The trace elements form a group of which their absence incidental to brucellosis has been measured under practical conditions. Supplements are commercially available that furnish measured amounts for correcting gross deficiencies of manganese, copper, cobalt, magnesium, iron, and zinc. To this list further elements can readily be added as techniques are developed that show the need of them. All in all about 37 different inorganic elements have thus far been found to be in one or another way involved in the fabric of life, and 23 thereof have been shown to be invariably essential to all forms of life. Man of course depends on his foods to contain them either naturally or as supplements.

In regard to the final group of *water, vitamins, enzymes*, and *hormones*, the loss of water is continuous so its constant need is obvious. Water as such furnishes the two well known elements hydrogen and oxygen and as it contains no carbon, could be classed as an inorganic nutrient. But it is of course present as moisture in all foodstuffs not dehydrated, and combined with other solutions. The bulk of our bodies consists of such solutions.

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The International Geophysical Year

• By Dr. J. Wallace Joyce
HEAD, OFFICE OF THE INTERNATIONAL GEOPHYSICAL YEAR, NATIONAL SCIENCE FOUNDATION

This is a talk given by Doctor Joyce before The Scientific Research Society of America in Philadelphia on January 28, 1956. It briefly describes what the scientists hope to accomplish during the International Geophysical Year.

Scientists of fifty-six nations will collaborate in this greatest of world-wide scientific undertakings.

We believe that all teachers of science should be informed on the purpose and the procedure to be followed during the IGY.

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The Whole World — A Laboratory

Man has always been interested in the problem of his physical environment. This curiosity and his efforts to satisfy it have increased to an unprecedented degree in recent years and today provide the stimulus for a program of scientific cooperative effort without parallel in history—the International Geophysical Year.

The scientific disciplines most directly concerned in supplying the answers to the problems of our physical environment are broadly classed under the term "geophysics." The term "geophysics," as here used, includes studies of the earth, its gaseous mantle known as the atmosphere, and the adjacent region of space beyond the bulk of the atmosphere.

Now, the geophysicist in approaching his problems faces a handicap or, perhaps it is better to say, a challenge that the physicist, the chemist, or the engineer does not usually encounter. In the latter disciplines, laboratory experiments under carefully controlled conditions provide powerful tools in prying open many of nature's secrets. In geophysics, however, nature herself becomes the experimenter. She performs the experiments, with the whole world and its environments her laboratory, and man must carefully observe these experiments and exercise great ingenuity if he is to reach the correct interpretation of his observations. It is only by this means that he may eventually come to an understanding of the basic causes behind the many complex and interrelated manifestations that go to make up his environment.

Careful observations, therefore, lead to understanding, and understanding is often a prelude to adaptation or, in some cases, to possible control.

An ideal vantage point from which to observe many of nature's phenomena would be from a position in space, outside the earth's atmosphere, but of course with instruments which could "see through" this atmosphere. Such a possibility is too far removed from present technological capabilities to consider at present, although as we shall see later, the earth satellite does afford us the opportunity of placing scientific instruments in space for sustained periods of time.

Historical Background

The next best thing to our "point in space" is a plan that will provide data on the phenomena we wish to study over the entire earth within a relatively short interval of time. The inherent advantages of such a plan were clearly recognized by geophysicists in earlier periods. Such a recognition on the part of Lieutenant Karl Wayprecht, a young German Arctic explorer, led to a period of simultaneous cooperative observations on the part of ten nations, including the United States, in the Arctic. This undertaking, organized on an international basis following its presentation to the International Meteorological Congress in Rome in 1879, began about August 1, 1882 and terminated about September 1, 1883. It was known as the First Polar Year.

From a scientific point of view, the First Polar Year was eminently successful. It clearly demonstrated the effectiveness of relatively simultaneous observations over a large geographic area in dealing with such transient phenomena as meteorological conditions, terrestrial magnetism or geomagnetism, and the aurora. The results of the First Polar Year increased materially the store of knowledge of surface meteorological observations in areas hitherto inaccessible to the meteorologist. At the same time, information concerning the geographic distribution of the geomagnetic field was extended to the polar regions and the character of the northern auroral zone, worked out by Fritz several years earlier, was confirmed and refined.

Fifty years after the First Polar Year the Second Polar Year was undertaken. Again a German, Dr. Johannes Georgi, a meteorologist, is credited with the initial proposal. At a meeting of the International Meteorological Conference of Directors in Copenhagen in 1929, the Commission for the Polar Year 1932-33 was appointed, with Dr. D. la Cour, Director of the Danish Meteorological Service, as its President.

Despite the fact that the Second Polar Year occurred during the depression of the 1930's, more than 30 nations participated in the undertaking, which extended for a year starting August 1, 1932. Over 100 special stations, primarily in the Arctic, were occupied.

Meteorology, geomagnetism, the ionosphere and aurora, benefited most from the Second Polar Year. In meteorology, emphasis was placed on aerological observations in contrast to surface observations taken during the First Polar Year. A new instrument, the radiosonde, was introduced during the latter part of the period. I need not remind this audience of the important place this instrument holds in meteorological activities today.

Another important result of the Second Polar Year was the recognition of a correlation between radio blackouts and periods of great geomagnetic and earth-current disturbances. Ionospheric studies also received a great impetus.

The circumstances that led to the greatest international scientific venture of all—the International Geophysical Year—were touched off in a most casual and unexpected way. In April 1950, a group of scientists met informally at the home of one of them in Silver Springs, Maryland. We were there to greet Dr. Sydney Chapman, one of the world's great geophysicists who was passing through, and incidentally to discuss the current status of geophysics. In particular, we wondered what the future of geophysical research should be, now that the war was over and geophysics could again be pursued on a world-wide scale. Lloyd V. Berkner, who is well known to most of you for his many contributions in the study of the ionosphere and related fields, called attention to the tremendous advances in instrumentation that had taken place during the 1940's. He said that he thought it would be a shame, in view of the new instruments and techniques that were available, to wait out the whole 50 years before a Third Polar Year was held. He suggested that consideration be given to holding a Third Polar Year 25 years after the second, which would place it in 1957-58, a period that was also close to a sunspot maximum. The suggestion was received with enthusiasm.

In later discussions scientists recognized the great benefits of extending the planned program to encompass the entire earth. Accordingly, the event was renamed the International Geophysical Year to reflect the increased scope in coverage.

During the next 18 months the initial proposal was considered and supported by a number of international scientific groups, most of them members of the International Council of Scientific Unions. The Mixed Commission on the Ionosphere endorsed it as did, also, in rapid succession, the International Scientific Radio Union, the International Astronomical Union, the International Union of Geodesy and Geophysics, and finally the International Council of Scientific Unions itself.

International Organization for the IGY

In late 1951 and early 1952, nations adhering to ICSU were invited to establish special national committees to take part in the planning and guidance of the IGY. At the same time ICSU established a special committee for the International Geophysical Year, called CSAGI, from the initials of the French name of the committee. The CSAGI was to be the guiding body, responsible to ICSU, for preparing a coordinated and agreed-to scientific program for the IGY, within the time schedule necessary to permit the start of observations in all areas on 1 July, 1957.

The CSAGI was composed of representatives of the various scientific Unions involved, including Astronomy, Geodesy and Geophysics, Scientific Radio, Pure and Applied Physics, Geography, and Biological Sciences. Representatives were also designated from the World Meteorological Organization (WMO), whose cooperation had been early sought and enthusiastically given, and, later, from the International Consultative Committee for Radio Communications (CCIR). Finally, ICSU appointed a Bureau of CSAGI, consisting of Professor Sydney Chapman, President; Dr. Lloyd V. Berkner, Vice-President; and Professor M. Nicolet, General Secretary.

From among its members, including the Bureau, CSAGI designated a series of "Reporters," one for each of the disciplines to be covered, namely: Meteorology, Geomagnetism, Aurora and Airglow, Ionosphere, Solar Activity, Cosmic Rays, Longitude and Latitude, Glaciology, Oceanography, Seismology, Gravity. Reporters were also designated for World Days and Rockets and Satellites. The latter two are special subjects about which more will be said later.

The Reporters were to act as focal points or conveners for the development and coordination of world-wide programs suitable to the IGY in their respective fields of interest.

In order to coordinate the various scientific and related activities in certain geographically plausible subdivisions of the earth, adjoint secretaries were appointed for the Antarctic, the Arctic, Eastern Europe, Southern Africa, and the Western Hemisphere.

In describing the duties of the Reporters, I have used the term "programs suitable to the IGY." The need to establish criteria against which to judge the suitability of suggested programs for inclusion in the world-wide program of the IGY was clearly recognized by the CSAGI. The following, in their relative order of importance, were enunciated soon after planning started:

(a) geophysical problems requiring for their solution concurrent synoptic observations at many places on the globe, involving coordinated efforts by many nations;

(b) geophysical problems, the solution of which will be aided by the availability of the results of synoptic or other concentrated geophysical work undertaken during the IGY;

(c) observations of other major geophysical phenomena where the main program involves the occupation of stations in regions of the earth to which comparatively little geophysical effort has been devoted in the past, but which will, as a result of the IGY, be areas of accelerated interest. The Antarctic and certain equatorial regions are examples;

(d) observations of slowly varying geophysical phenomena, for comparison with similar future observations at later epochs.

With the expanded concepts of the IGY came invitations to all countries of the world to join in the enterprise. To date, 56 have organized national committees for the IGY and are taking some active part in the venture.

In general, the various countries provide the funds, equipment, and personnel for IGY activities that they undertake within their continental limits, possessions, or in areas where they have traditionally had an interest. Thus, the magnitude of the IGY program depends on the degree to which each nation supports its own program. Bilateral arrangements may be made between individual countries to cooperate in common

projects, but such arrangements are outside CSAGI channels. Naturally, however, CSAGI welcomes any arrangements that contribute to the scope and success of the enterprise.

The United States National Committee for the IGY

The National Academy of Sciences—National Research Council adheres to the ICSU and most of its Unions on behalf of American scientists. The U. S. National Committee for the IGY was established by the National Academy of Sciences in February 1953, and Dr. Joseph Kaplan, a well-known physicist from the University of California at Los Angeles was appointed Chairman. Dr. Alan H. Shapley of the National Bureau of Standards is Vice-Chairman and Mr. Hugh Odishaw, formerly of the National Bureau of Standards, is the Executive Secretary. The Committee membership provides appropriate representation from the various scientific disciplines and institutions involved.

The Academy-Council recognized the importance of Government cooperation and support to the success of the United States portion of the IGY program. In the fall of 1953, the Academy-Council invited the National Science Foundation to coordinate the interests of the U. S. Government and to obtain and administer government funds required to carry out the United States IGY program.

The National Science Foundation accepted the invitation and established an office for the IGY. With the effective help and cooperation of the U. S. National Committee, the Foundation went to the Congress for funds for the scientific program and received a total of $39,000,000.

Retracing for a moment some of the points I have just made, we see that CSAGI has the responsibility of planning a coordinated world-wide scientific program appropriate to the IGY. This program is synthesized from various proposals submitted by individual nations, modified through periodic meetings of CSAGI and national representatives. Four such planning meetings have been held: in Brussels in 1953; in Rome in 1954; in Brussels in 1955; and in Barcelona in 1956.

Individual countries are responsible for organizing and supporting their own portions of the IGY program. In order to provide national viewpoints in the deliberations of CSAGI, an Advisory Council for the IGY was established to consist of the chairman of each national committee for the IGY or his accredited representative. By this means, country capabilities are taken into account by CSAGI in deciding on over-all IGY programs.

Evolution of the Program

Let us now examine briefly the various stages that project proposals go through from the time of their inception to the time when observations will be made as a part of the total IGY world effort. For this exercise, we shall use the USNC-IGY as an example of the country phase of the operation.

First, the project proposals may have their inception in the individual laboratories, or in the minds of individual scientists. Much of the strength of the IGY stems from this fact—that ideas and support originate at the grass-roots level in the scientific community. The original idea is first subjected to a screening process within the framework of the National Committee. In the United States this initial screening takes place in one of the fourteen technical advisory panels that has been established under the USNC-IGY.

The various individual projects that are accepted by the panel are then consolidated into a proposed disciplinary program in meteorology, or geomagnetism, for example. The disciplinary programs are next brought together into a proposed national program at Committee level. At this point a certain amount of trimming becomes necessary, for inevitably a vigorous scientific community will usually generate far more suggestions than can be supported. After the complete national program has been adjusted to come within the country's budget, it is sent as a proposal to the General Secretary of CSAGI, who receives many such national program proposals.

A meeting of CSAGI and representatives from participating countries is called to review these programs and out of them to prepare the first draft of an international program. Working groups in the various disciplines are selected from among country delegates, generally capable scientists in the various fields of interest. These working groups are chaired by the appropriate CSAGI Reporters. The synthesis of the international program results in modifications to the individual country programs, which must then go back to the national committees for reconsideration and implementation.

During the planning period for the IGY, additional suggestions for projects were received after the first cycle of approvals, necessitating a certain amount of re-examination, adjustment, enlistment of additional country support and the reconsideration of international aspects of the program. The United States IGY earth satellite project is a case in point. It was not until after the Rome meeting of CSAGI in 1954 that the U. S. National Committee determined that it was feasible technically to accept the CSAGI invitation to attempt to place a scientific earth satellite on orbit during the IGY period. Similarly, programs in seismology and gravity were introduced after the initial review, and significant additions were made to many other programs.

By the fall of 1956, when the fourth general meeting of CSAGI was held in Barcelona, the world program had been agreed to with but few minor exceptions. Certain operating details were still unresolved, but the nature of these problems was clearly understood and solutions were in sight.

Fields to be Covered

Now let us take each broad geophysical discipline and examine some of the problem areas and unanswered questions. To emphasize certain recognized interrelationships that exist, I shall group the disciplines under three broad categories:

(1) Physics of the upper atmosphere — including solar activity, cosmic rays, aurora and airglow, the ionosphere, and certain aspects of geomagnetism.

(2) The lower atmosphere—including surface and interface problems—as well as meteorology, oceanography, and glaciology.

(3) The crust, interior, and figure of the earth—including seismology, gravity, latitude and longitude determinations, and certain aspects of geomagnetism.

Solar Activity. The sun is the source of most of the energy upon which man depends for his very existence. The behavior of many of the geophysical phenomena that we shall observe during the IGY relate in various ways to the sun's activity. One of the most commonly observed examples of this kind of interrelationship is the disruption of radio, and sometimes even of wire communications during periods of extremely active sunspots. In some cases we feel that we have reasonable clues to the relations that exist. In others, the clues are still either very obscure or unrecognized. A careful study of solar activity and its possible correlation with many of the phenomena that occur throughout the upper and lower atmosphere and within the earth itself can be expected to yield important knowledge.

Many of you are familiar with the 11-year sunspot cycle. This cycle provides a means for measuring the average level of solar activity. Of great interest also are the individual transient events such as flares, eruptions, sunspots, and other manifestations.

In order to obtain the basic data needed to recognize possible interrelations between solar events and upper atmospheric phenomena, scientists will keep the sun under continuous observations, both visual and electronic, during the IGY period. Sunspots, flares, eruptions, and coronal activity will be observed by means of a wide range of specialized instruments, including spectroheliographs, spectroscopes, flare patrol instruments, and radio astronomical telescopes.

We know, for example, that streamers of charged particles from the sun reacting on the tenuous substance of the upper atmosphere cause aurora, and that variations in ultra-violet emanations are associated in some way with changes in the ionization of parts of the upper atmosphere, but the underlying forces that cause such changes in the sun itself are still not understood. Furthermore, since the atmosphere acts as an attenuator and moderator of many of the radiant and particle emanations that reach its outer layers, we need some means of measuring these quantities beyond the bulk of the atmosphere. In the middle 1940's American scientists began to experiment with rockets as devices for lifting their delicate instruments to high altitudes in order to make various types of physical observations in the upper atmosphere. Their activities have been richly rewarding in the development of effective high-altitude-rocket-soundings systems. Through their use we have been able to confirm by direct measurement many of the quantities that could only be determined by indirect methods up to that time.

Although the rocket is a very useful device for measuring vertical profiles through the atmosphere, the time during which it remains at or near its peak altitude is extremely brief. Furthermore, a single rocket ascent gives data along only a single vertical section. To overcome these difficulties many of the rocket experimenters have recognized the need for an artificial satellite, which can be placed beyond the bulk of the atmosphere and which would provide data on time variations and space distributions of various types of phenomena, such as solar ultra-violet intensities, solar-particle emanations, and cosmic rays. I shall have more to say about the satellite program later in this address.

World Days. It was clear from the outset that intervals of more intensive observations on a world-wide basis would provide extremely useful information to the research worker. Accordingly, CSAGI's plans include provision for a series of "World Days," of which there are three classes: "Regular World Days," "World Meteorological Intervals," and "Special World Intervals," with associated periods of "Alerts."

The first and second classes are selected in advance. Thus, there have now been designated three or four "Regular World Days" for each month of the IGY period. Two of these are consecutive days at the time of the new moon; the others occur at times of unusual meteor showers or near one of the lunar quarter phases. Also included in the "Regular World Days" are days of solar eclipses with adjacent days for control observations.

The "World Meteorological Intervals" are series of ten consecutive days in June, September, December, and March. They always include either an equinox or a solstice. During these intervals special programs in meteorology will be carried out.

The "Special World Interval" category was established to provide for stepped-up observations whenever solar activity is unusually high and significant auroral, cosmic ray, ionospheric, or geomagnetic effects are probable. These periods are selected on the basis of advice to be provided by a series of forecasting centers throughout the world. The final decision for announcing a "Special World Interval" rests with the IGY World Warning Agency, located just outside Washington on the grounds of Fort Belvoir.

When a forecast indicates the desirability of a Special World Interval, the IGY World Warning Agency will send an Alert, or stand-by instruction to all participating stations throughout the world. The communication network required to carry these messages is now being arranged. It will operate through three additional regional and a whole series of country centers. When an Alert has been issued, a Special World Interval may be declared on eight hours' notice.

The effectiveness of this plan depends basically on a smooth and effective communication plan. To insure that such a plan will be in operation by the start of the IGY on July first, test operations are now going on. The speed of distribution from Washington to the individual stations throughout the world is one key to effective operation. It must be accomplished within a relatively few hours, over-all, and any communicators in this audience will recognize the magnitude of the operation.

Cosmic Rays. It is generally agreed that cosmic rays consist of very-high-energy-charged particles such as protons or combinations of protons and electrons, but the precise nature of these particles, how they come into being, and where they come from in space are all unknowns.

Cosmic rays bombard the earth from all directions. Because of the high energy of the primaries, as opposed to secondary cosmic rays produced by bombardment of atmospheric particles by primaries, they are only slightly affected by the geomagnetic field. Solar activity has an effect on their intensity and behavior. We do not know whether this effect is owing to the fact that some have their origin in the sun, or whether they are simply influenced in passing the sun on their journey from more remote regions.

Primary cosmic rays do not in general reach the earth's surface because they are absorbed or modified in passing through the atmosphere. In order to determine the precise nature of these primaries, however, we need to know many things about their nature prior to their entry into the upper atmosphere. One such quantity is their energy spectrum. It is planned to measure this by means of rockets, and if possible, the satellite.

More precise and extensive data will also be sought on space-and-time variations in intensities of both primaries and secondaries. All such information should contribute to the solution of the questions of "where, how, and why."

Aurora and Airglow. One of the most spectacular manifestations of solar effects on the upper atmosphere is the aurora. Caused by bombardment of the very rarified regions of the upper atmosphere by charged particles from the sun, the aurora appears generally only at high latitudes. In fact, the two zones of maximum auroral occurrences are centered about the earth's two geomagnetic poles. This distribution of aurora is known to be associated with the geomagnetic field which deflects the incoming charged particles towards these two poles.

Networks of stations in both north and south polar and sub-polar regions will detect, record, analyze, and map auroral occurrences. All-sky cameras and visual-observer programs will keep track of the sky during periods of darkness. During daylight, or when clouds obscure the sky, radar equipments will serve as electronic eyes. Radio-noise measurements and radio-astronomical observations will add their share to the vast amount of data that will be collected. From studies of these data we hope to answer many questions and to obtain a better and clearer understanding of the basic processes that produce ionization and chemical changes in the upper atmosphere, a clearer picture of auroral distribution and intensity during both daylight and night hours, and some idea as to whether individual events occur simultaneously in both northern and southern hemispheres. From such studies may well come such practical gains as, for example, better and more reliable communications systems, particularly across the auroral zones and in high latitudes.

In addition to the light of the aurora, there is present in the night sky a very faint glow called airglow. The source of this faint light is now thought to be chemical processes in the upper atmosphere, rather than incoming charged particles as in the case for the aurora. By carefully keeping track of the variations in intensity and the distribution of airglow, we should learn more about the exact manner in which it occurs, information that should help us in our quest for answers to the processes that occur in the upper atmosphere.

Ionosphere. The earliest evidence of the existence of the ionized region that exists at levels of from 50 to 250 miles above the earth came when Marconi succeeded in sending radio signals between North America and Europe in 1901. Yet it was not until 1925 that Breit and Tuve performed their classic experiment which demonstrated that a radio signal, sent directly upward, would be reflected by this electrified layer back to a receiver at the point of origin. The Second Polar Year provided a powerful stimulus to ionospheric research, and observations during that period gave us, for almost the first time, some idea of the characteristics of the ionosphere in polar regions.

The function of the ionosphere in relation to radio communications makes an understanding of its characteristics of more than passing interest from a practical point of view. We know that this region is one of great complexity and constant change; daily, seasonal, yearly, and regional variations occur. A carefully planned world-wide network of stations will gather data to increase our knowledge of these variations. Attention will also be given to interrelations with other geophysical phenomena, including solar activity. The World-Day schedule will be an important element in these operations. High-Altitude-rocket observations will also add to this information and in fact provide the calibration tools that greatly improve the usefulness of vertical and oblique incidence transmitters and receivers in solving the mysteries of the ionosphere.

Geomagnetism. The geomagnetic field of the earth has long been the subject of careful observation and study. It received major attention in both the First and Second Polar Years, and the International Geophysical Year will be no exception.

Geophysicists will seek more detailed information on the characteristics of the geomagnetic field, its behavior during solar disturbances, its diurnal and secular variations, and other quantities. They will devote special attention to registration of magnetic elements during great magnetic storms and periods of rapid field fluctuations, some of which appear only at high latitudes, while others are observed over the entire earth. Interrelations with solar activities and other disciplines will be studied, also. Finally, we are still faced with the unanswered question of the cause and source of the permanent component of the geomagnetic field. This permanent field accounts for roughly 98 per cent of the intensity at a given point on the earth's surface, the remaining 2 per cent being about the maximum range of time variations caused by related solar effects. One might argue that the basic causes for the earth's magnetic field are of no great practical consequence, but

(Continued on Page 36)

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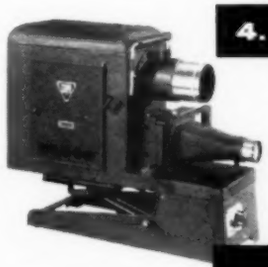

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New Books

Elements of Algebra

• *By* HOWARD LEVI. Second Edition. New York: Chelsea Publishing Company. 1956. Pp. 160. $3.25

This experimental three-credit course on the first year College level was given for three years at the School of General Studies of Columbia University before the first edition of the text was published in 1953. The success of the text is attested by the demand for this second edition. The course provides a very elementary and sketchy introduction to the axiomatic method of modern mathematics for liberal arts students taking their final course in mathematics as well as for students intending to pursue further courses. The scope is extremely limited; concentration is on the basic notions of the construction of the natural numbers, the integers, rationals and reals, and upon the elementary operations on these number systems. Discussions are as simplified as possible and are meant to guide the beginner through his first few faltering steps in mathematical reasoning. The spirit of the work is similar to that of J. W. Young's *Fundamental Concepts of Algebra and Geometry* or of E. Landau's *Grundlagen der Analysis* but it is much more limited in its coverage. The title *Elements of Algebra* might be misleading for one who is not acquainted with such a text as Marie J. Weiss's *Higher Algebra for the Undergraduate;* very few algebraic manipulations, and those only of the simplest type, are introduced. Even in the realm of numbers, the author brings the student to the very brink of a discussion of irrational numbers and complex numbers but leaves him there without even a mention of those two intriguing topics.

Secondary school teachers trained in the "classic" tradition of the pre-Cantorian era may be looking for a simple introduction to modern mathematics such as this for their own personal study. Work on the foundations of mathematics has made rapid progress in recent years and has already had its effect on the organization of even first-year college courses. Sets, groups, functions, isomorphisms, Peano axioms, Dedekind cuts and transfinite numbers are no longer merely topics of interest to isolated theorists. High school textbooks and teaching methods are bound to be influenced by the newer methods of modern mathematics and the alert teacher will be prepared for subtle changes bound to come. For those interested in a very much simplified introduction to a very few basic concepts of modern mathematics Levi's *Elements of Algebra* is recommended.

John P. Gallagher, C.S.Sp.
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Photo by Vic Kelly

Science in the Making

• *By* JOEL H. HILDERBRAND. New York: Columbia University Press. 1957. Pp. 116. $3.00.

This brief, informative and pleasantly non-pedantic book presents the views of an outstanding leader in science and in science-education on the ways in which scientists acquire new knowledge. The reader may not always agree with the author's opinions, but he must admit that they are based on sound reasons.

The book contains the four 1956 Bampton lectures. The titles of the lectures are: *The Search for Knowledge, False Paths, Science has its Cathedrals* and *Knowledge and Power.*

Doctor Hilderbrand deals with science as an enterprise rather than as a collection of facts, and concentrates on the analysis of scientific statements. His criticisms of the misuses of science supply an excellent answer to those who make a "sacred cow" of science, and to those who, because they confuse material well-being and materialism, deplore the advance of science. We recommend this book to all who are seriously interested in the nature of science. *J.P.M.*

Physics for Everybody

• *By* GERMAINE and ARTHUR BEISER. New York: E. P. Dutton & Co., Inc. 1956. Pp. 191. $3.50.

Here is a book that you can recommend to your non-scientific colleagues, who consider physics too dry and too mathematical to be interesting. It is well written, easy to read, scientifically accurate, and nonmathematical. In the preface the authors state, "In writing this book our intention was to introduce some of the basic ideas of physics to a nontechnical audience. The only equipment required of the reader is curiosity—and we hope that he will leave the book even more curious about our remarkable universe than when he started reading." We feel certain that its readers will be made more curious about physics. We also feel that this and similar books will help the science teacher to make the presentation of his subject matter more interesting.

This is not a text book, and we recommend it for both high school and college libraries. *J.P.M.*

Mathematics, Magic and Mystery

• *By* MARTIN GARDNER. New York: Dover Publications. 1956. Pp. xii + 176 (Paper). $1.00

This book deals with tricks of "magic" that are based on mathematical laws. The procedure followed in performing the tricks and the mathematical laws on which they are based are explained. The amateur magician and the mathematician will find much of interest in this little book.

We recommend this book to teachers who are looking for material to show that mathematics can be fun, and to producers of student shows. *J.P.M.*

Source Book for Science Teachers

• *Published by* UNESCO. Paris, 1956. Pp. 220. $3.00

Elementary and secondary school science teachers will find much useful information in this source book. It contains detailed information on the construction and use of simple, but highly effective laboratory equipment. The descriptions of the method of constructing and using the equipment are clear and complete, and its illustrations clear up any difficulties which the reader may encounter in reading the text. One chapter is used to present some useful notes for teachers.

Shortly after World War II, UNESCO published a highly successful book, *Suggestions for Science Teachers in Devastated Areas.* This source book was prepared by rewriting and adapting the earlier book for use in schools with limited budgets.

The source book contains many well planned experiments in botany, zoology, minerals and fossils, air pressure, water, weather, physics, chemistry and general science. We recommend this book to all teachers of elementary and secondary science. *J.P.M.*

Your Career in Physics

• *By* PHILIP POLLACK. E. P. Dutton and Co. New York. Pp. 127. $2.75.

Teachers and counselors will find this little book to be an invaluable aid in advising students interested in a career in physics. Philip Pollack reduces the questions students ask to three. (1) What are the qualifications of a physicist? (2) What is the work of a physicist like? (3) How can I tell if I should become a physicist? His answers to these questions make up the content of the book.

The author discusses the qualifications of a physicist and briefly but accurately describes the principal fields in which physicists work. He presents the various fields in an attractive and authoritative manner. He does not minimize the difficulties nor does he exaggerate the more attractive side of physics. The serious student, who has the ability and interest, will find the author to be a convincing salesman.

We strongly recommend this book to student advisors and recommend that a copy be placed in the student library. *J.P.M.*

★ ★ ★ ★ ★

"However useful science is to investigate the privacy of tiny chambers called atoms, it is all but useless to investigate the inner and higher life of man. You can't examine free will in a test-tube. Yet much of what man does for weal or woe springs from this inner life of free choice." THOMAS E. MURRAY

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Living with 10,000,000 Deer

(Continued from Page 2)

Deer damage to farm crops, orchards and nurseries in the "deer states" is now so common that we have learned, in one way or another, to live with it. Some states investigate claims for damage and make payments from hunting license funds. Others attempt to reduce ill feeling among farmers by supplying fencing materials, scaring devices and repellents. Still others permit farmers to destroy the offending animals. If deer confined their feeding to browsing on tree sprouts, saplings and shrubs within wooded areas, there would be few disgruntled farmers, but they do not. Unfortunately, deer like to graze on the green shoots of fall-planted wheat and rye, they are fond of soybeans, corn and buckwheat, and they delight in polishing their antlers on the small limbs of young peach, apple and other orchard trees. Such trees are often slashed to ribbons after the buck deer have had an antler-polishing session in the late fall or early winter. California estimates that at least $150,000 and not more than $800,000 worth of damage is being done by deer to crops annually in that state. This does not mean much to the economy of the state, but it does mean a great deal to individual farmers who experience losses of more than $1000 in one season or even one week. The amount of crop damage by deer to some individual farmers is often large in comparison with their gross income and consequently represents a considerable part of the profit.

Deer are a constantly growing source of danger to motorists, especially on the great super highways of the eastern and middlewestern states. In Ohio alone, which has a deer population of only about 28,000, more than 500 of these animals were killed by autos during 1955. While there is seldom loss of human life in these accidents, nevertheless the tension of driving on deer-frequented highways, and the almost certain damage to one's car when a deer is unavoidably struck, cause apprehension among highway officials and highway users alike.

Notwithstanding the many blunders in managing our deer herds, and the helplessness of game managers sometimes in dealing with the problem of herd control, deer have a great economic and aesthetic value to our citizens. No dollar and cents value can be placed on the unexpected glimpse of a living deer in the wild. To many, these graceful animals are a link with pioneer days. People will travel many miles to see a deer, even in captivity. An Ohio game protector rescued two white-tail fawns when their mother was struck by an auto and put them into a small enclosure. In a short time people began coming to see them. Throughout the summer and fall visitors arrived in an almost steady stream. The number dwindled on week days, but on Sundays as many as two hundred persons, many of them children, stopped to see the fawns. There might have been more but there was not enough parking space!

The amount of wholesome, outdoor recreation enjoyed by deer hunters is incalculable. Aside from the value of the meat and trophies, which is considerable

in an annual harvest of more than one million animals, many millions of people benefit financially when two million hunters in the United States and Canada go afield annually to bag their deer. Restaurant owners, hotel and motel operators, sporting goods dealers, filling stations, all benefit from the largesse that is distributed far and wide by the deer hunter. Even the farmers gain by taking in boarders during the deer season and selling farm produce to the hunters. California estimates that the average deer hunter spends $41.60 for each deer hunting trip whether he is successful or not. Seventy-five dollars was spent for each deer killed, and considering that 47,000 deer were taken in 1947, approximately $351,000 was spent by successful hunters.

It cannot be said that we have learned to live successfully with a population of 10,000,000 deer. The problem is a complex one; it involves not only the application of sound ecological principles, but social and economic values as well. Fortunately, the deer problem is confined to "trouble spots." Many states are intelligently solving their deer problem. In those that are not, human sentiment is perhaps the greatest drawback to the initiation of sound deer management. Perhaps when people learn that deer, like all other game animals, should be handled as an annual crop, that a renewable resource such as this will go to waste if it is not properly harvested—then deer and people will be able to live in harmony. ●

★ ★ ★ ★ ★

Tobacco Mosaic Virus

(Continued from Page 5)

4 $m\mu$ were seen. With solutions containing active reconstituted TMV the characteristic rods were found. By applying Hart's technique the RNA was found in the center as is the case with the original whole TMV. This is the first case of a virus being degraded to inactive components and then reconstituted in a test tube to the active particle. Thus, once again research with tobacco mosaic virus has resulted in important new knowledge for the science of virology.

It should not be thought that TMV is the only virus studied by electron microscopy and other physical chemical methods although at times it would seem so. Many plant, animal, insect, and bacterial viruses have been examined. but mainly because of the ease of purifying TMV scientists have had a continuing "romance" with it. It appears that this virus will still be "the first" in many new approaches to the virus problem just as so many important "firsts" have been made with it in the past. ●

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Wildlife Conservation

(Continued from Page 11)

ticipation in school club activities, as committee members or officers, also provides good experience in working with people and developing administrative ability.

Students who wish to become game technicians would do well to get a good grounding in biology, chemistry, physics, and mathematics. Game managers are expected to know the common plants and animals and something about their interrelationships and dependence on the soil. Also, game management agents often will need to be familiar with agricultural practices, including the planting and care of various crops useful as wildlife food or cover. For this reason, courses in agriculture are desirable, as well as some work experience on farms.

Students may find it possible to work with or become acquainted with local conservation officers, thus gaining some firsthand experience or knowledge of wildlife management operations. Participation in 4-H Club or Boy Scout programs which include conservation projects will provide additional experience.

The number of temporary paid jobs available for high school students in Federal conservation agencies probably will be limited, but students and high school science and mathematics teachers alike may be interested in a recent (1956) revision of U. S. Civil Service Commission's Schedule A, Section 6.101(s). This permits high school science and math teachers to be appointed without competitive examination as assistants to scientific, professional, or technical employees on a temporary or intermittent basis. This Section reads as follows:

> "(s) Temporary or intermittent positions when the appointees are to assist scientific, professional, or technical employees. Persons employed under this provision shall be bona fide students at high schools or accredited colleges or universities pursuing courses related to the field in which employed, *or bona fide high school science and mathematics teachers.* No person shall be employed under this provision (1) in a position of a routine clerical type; or (2) in excess of 130 working days a year; or (3) at a total compensation exceeding $1,270 during such a period of one year".

This Schedule as revised will permit the Government, as an employer, to participate in a growing national effort to improve the quality of high school science and math teaching. The program is being spearheaded by the National Science Foundation through the National Academy of Sciences and in cooperation with professional organizations and industry.

During the Junior or Senior year in high school, students who are considering a career in wildlife conservation might benefit by writing to some of the colleges and universities offering training in this field and getting literature concerning entrance qualifications, types of courses offered, degrees granted, etc.

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The Wildlife Leaflet 352, mentioned above, lists most of the colleges and universities offering such courses, but the information on courses available, and other details should be obtained from the respective colleges and universities.

Regardless of the college selected, it would be to the student's best interests to get the most out of his high school training and to graduate with good grades. There are few high school courses which would not, in one way or another, directly or indirectly, be of value in the early training of wildlife managers. Getting a sound basic training in the life and physical sciences, learning to read, write, and speak effectively, and learning to work and get along well with people will be especially valuable. Specialized training in wildlife usually must be postponed until a student is well along in his college career. The fact that a student likes to hunt or fish is no assurance that he will be a successful wildlife manager. Competition for jobs is becoming keener; but, as in other fields, there is a job turnover; and, other things being equal, the best qualified candidates get the jobs.

Although the pay for wildlife conservation employees is not high (annual salaries for professional workers beginning at about $3600 and seldom exceeding $10,000), the work is challenging. Wildlife populations are never static; they change with habitat changes; and new problems are occurring constantly. A better understanding of wildlife resources and their management on the part of high school students should help insure progress in this field. This is true whether the students later become wildlife managers, or like the majority of the nation's citizens, simply enjoy the resources esthetically or as hunters and fishermen. ●

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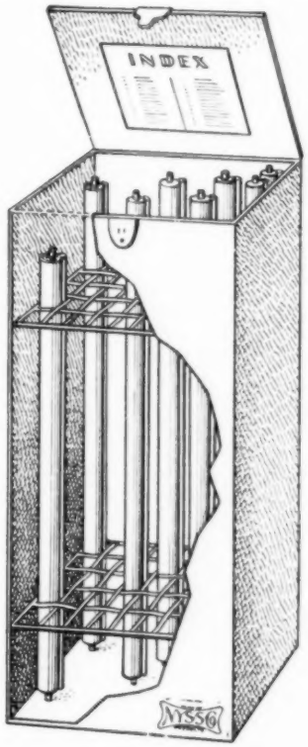
We have seen the first three numbers of the 1956-57 volume and they are excellent. The articles are well planned and excellent in content, and the format is very pleasing. Each issue has eight pages (8½ x 11), there are no ads and the illustrations are well chosen. We recommend that you try using it in your classes.

Subscriptions can be obtained by writing to the *National Science Teachers' Association*, 1201 Sixteenth Street, N.W., Washington 6, D. C.



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But Numbers Aren't Enough

A basic general science test used by certain grammar schools in New York was recently given to a group of college juniors and seniors preparing for teaching, including science teaching in elementary schools. They would, presumably, have no difficulty in correctly answering a simple basic test of elementary science. The results, however, were shocking. Whereas the average grade school student answered 85% of the questions correctly in approximately thirty minutes, the average collegian was graded at 73% after considering the test for one hour—with the book open!!

Although this group of future science teachers may excel in teaching theory and methods, (indeed we are told that several of them were most lucid in their pedagogical criticism of the test) they demonstrated abysmal and dangerous ignorance of the fundamentals of a subject in which they would shortly be expected to instruct others.

Here are some of the typical questions most frequently missed and the replies. (The best answer was to be selected from the multiple choices given.)

1. The best way to extinguish an oil fire is to:

A. Use a soda-acid extinguisher.
B. Pour water on the fire by hose.
C. Cover fire with oxygen.
D. Cover fire with something that will not burn.

The popular choice was "C."

2. A magnetized needle is broken into two pieces. Which of the following statements is true:

A. Neither piece is magnetized.
B. Only one end of each is magnetized.
C. One piece is magnetized—the other is not.
D. Both pieces are magnetized and have magnetic poles at each end.

The future science teachers would destroy a magnet by breaking it in two—replying A.

3. When baking powder reacts with water in a cake batter the gas produced is:

A. Nitrogen oxide.
B. Tartaric acid.
C. Oxygen.
D. Carbon dioxide.

Our young friends would, for the most part, acidify our cake—replying B.

Air and water are the best conductors of sound according to the respondents.

From other replies we learn that gasoline mixes with electricity in an automobile carburetor; roller and ball bearings in automobiles provide us with elasticity in the springs; we may open and close a circuit with an electro-magnet or even a buzzer; evaporation is demonstrated by snow falling.

As we said, mere numbers aren't enough.

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Graphic Arts Research

(Continued from Page 8)

sition of the solution was not given, but when this process is used in conjunction with the Elfers Process, color process plates have been corrected automatically and halftone staging eliminated.

The Elgrama Automatic Engraver, developed in Zurich, Switzerland, is claimed to make line, halftone, and combination plates. The machine has a selection of halftone screens, ranging from 60 to 200 in 10 steps. Zinc is used for halftone subjects, and a plastic is used for combination and line subjects. The Elgrama can only make plates the same size as copy. None of these machines has been sold in the United States, although they are used in seven other countries and on order from eight more.

The Klischograph Electronic Engraver of Germany is now being used to make halftones in lead, zinc, magnesium, and aluminum. This machine is sold in the United States as the Engrav-A-Plate.

Of especial interest is the progress report from the German Institute of Graphic Arts Research in Munich on the development of an original letterpress halftone plate of nylon. This particular development is also being studied in this country. Its potentialities are most promising.

Some of the most dramatic and exciting graphic arts research developments are the wholly new and unique processes for graphic reproduction. Xerography, Telefax, RCA Electrofax, and Ferromagnetography have been reported. The most recent new process for printing is that of pressureless printing as accomplished on the Electronic Reproducer. Electrical attraction is used to attract the pigmented particles to the paper instead of pressure. A cloud of finely divided pigmented and electrically charged particles is used instead of ink. This process was invented by William C. Heubner. The Electronic Reproducer was developed by the Standard Register Company of Dayton, Ohio. One of these machines is actually being used for production work by the Standard Register Company. They predict that within five to ten years, the process will be in widespread use.

The problem of printability is receiving widespread research attention, and effective work is being done in the paper, ink, ink-paper relationships, and ink transference phases of the problem. Printability has yet to be defined satisfactorily. The word refers to the problems involved in accomplishing the highest quality of results consistent with the conditions involved in producing printing. Any single deficiency in a product or operation can reduce the quality of printing. The problems are therefore of interest to all of those producing and using any of the materials and equipment needed to print. The elements in printing operations that determine the quality of the final printed result are paper, ink, ink transference, and the plate or form. The properties and behavior of each of these elements that affect the quality of printing must be identified. Means for

measuring them need to be developed, and studies should be made to determine the best use of the results of such measurements in planning the production of printing jobs. The problems associated with printability are many. The scope of the summation of these problems covers almost all phases of the graphic arts except binding operations. Careful planning and coordination of research projects on printability are needed to avoid duplication of effort and expense. Printing management should consider supporting research studies on the problems of printability. The results of such investigations have a fruitful potential value for use in planning printing operations.

Conclusion

The future growth of the printing and publishing industries depends upon a continuing increase in the needs for printing. An increase in the volume of general business will not necessarily mean that the same percentage of increase in volume will carry over into the printing industries. The business statistics of the past few years verify this statement. A greater use of printing by present customers and the development of new markets are necessary.

Some new developments and improvements of present graphic arts processes would stimulate increased use of printing. Many customers are upping their requirements for functional performance and properties in certain printed items. Customer pressure continues for greater flexibility of processes, improved quality of appearance, lower production costs and increased speed of production. If there is an answer to meeting these requirements, it will be found through a well-organized and adequately financed research program.

Up to now, most of the graphic arts research has been supported by suppliers and customers. Actually many of the problems needing a research attack are in the areas of processing and technology. It is in these areas that the management of printing companies could help by expanding their support and participation in engineering and research programs. By jointly financing and coordinating research effort, the printers, suppliers, and customers would constitute an unbeatable team. ●

★ ★ ★ ★ ★

"But let us get back to the question of a man being a good scientist and a good Catholic; and let us inquire if there is anything in the Catholic Religion that psychologically conditions a Catholic young man against science, or would ill fit him for a career of scientific research. On the contrary, he has fundamental convictions that there is *order* in God's universe and that, in spite of its vastness, God has endowed us with intellects capable of discovering its unity or order."

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Science as a System

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Henry J. Koren, C.S.Sp., S.T.D., *(Catholic University)*
DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

This is a condensation of a chapter in the authors' book THE PHILOSOPHY OF SCIENCE. *Father van Laer is at present Professor at the State University of Leyden in the Netherlands. Father Koren is chairman of the philosophy department of Duquesne University and editor of the Duquesne Studies, Philosophical Series.*

This is an excellent discussion of the basic nature of science.

●

Introduction

Science as a system is by its very nature unthinkable without its relationship to man. On the one hand, it is the result of human thinking; on the other, it has meaning only insofar as in the written or spoken language it can become the spiritual possession of other human beings who, in their own way, assimilate and perhaps develop or modify the results others have obtained. Science as a system is not something rigid or static, but a dynamic whole which is born and grows, is subject to all kinds of changes, and is developed in scope and depth in and through the intellectual activity of men. As it exists in reality, science is never something purely objective, but a web of subjectivity and objectivity.

When we speak of the *structure* of science we mean the internal composition given to it by human activity. This *structure* is determined by the nature of the object studied, and by the way in which man is able to intellectually grasp it.

Our starting point will be the knowledge of science possessed by one who is, at least to a certain extent, at home in the world of science. We speak of positive and exact sciences, experiential sciences, physical and cultural sciences. What are the characteristic traits that can be found in each and every science, and the conditions which must be fulfilled before we can speak of 'science'?

1. Science Is a System

It is clear that any knowledge to which the name 'science' is given must show a certain coherence. It must constitute a coherent whole of interconnected things and their parts that is appropriately ordered. An enumeration of unrelated facts or data, no matter how much each of them be worth knowing, does not give rise to a science. Later, in Sections 6 and 7, we will determine more exactly in what this systematic character consists and how it arises.

Although this point is fairly obvious, nevertheless it needs to be stressed. Nowadays people are frequently held to be 'scientific' and 'intellectual' if they are in possession of a large amount of information about almost any subject under the sun, even if they have not the slightest idea at all regarding the interrelationship of the things known.

According to Newman, true science must be a makeweight against the popular journalistic pseudo- knowledge which comes from newspapers, Sunday magazines, book reviews, etc. If he were alive today he would undoubtedly add radio, movies and television.

2. A Science is Concerned with a Definite Field of Knowledge

The human intellect is not able to take hold of all knowable things under all possible aspects. In former ages, it was possible for a few outstanding intellects, such as those of Aristotle and Albert the Great, to dominate the whole of contemporary science. Yet, even in those times, certain branches of learning were clearly marked off as autonomous or quasi-autonomous realms of knowledge. At an early date astronomy and mathematics were considered separate sciences because of the characteristic nature of their object and methods. According as in the course of time the total of accumulated knowledge increased, and the development of technique offered new means of scientific investigation, it became increasingly clear that it was necessary to divide the immense realm open to scientific knowledge into definite fields, each of which gave rise to a special science.

3. Science is Preferably Expressed in Universal Statements

A mere description of the subject matter observed and studied does not constitute a science. Likewise, a mere enumeration of the problems which arise in a particular field of knowledge does not amount to a science. For in both cases there is no manisfestation of insight into the subject matter, which is required in any science. So efforts must be made to arrive at conclusions that are based upon an intellectual understanding and expressed in statements of the type 'so it is' or 'so it ought to be'.

In general, every science tries to acquire an insight into the specific nature of things, their specific properties or activities, and also the essential interconnection of phenomena according to their specific character. Thus the individual as such does not lie in the center of scientific interest, but only the individual insofar as it can be considered to represent the specific. For instance, the physicist is not interested in this particular source of light or that particular magnet, this individual sample of water or helium, but in the

(Continued on Page 32)

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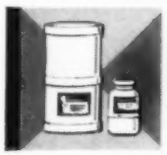

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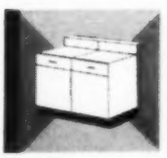

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Science as a System

(Continued from Page 30)

properties of light, magnets, water or helium which he wants to define in universally valid statements.

Nevertheless, it may happen that science is interested in individual and concrete objects or events; e.g. in astronomy, the sun, the moon, particular planets, and other celestial bodies are studied; in geology, the earth is considered with respect to its actual appearance as a whole and in its parts. However, even in such cases what matters is usually not the individual as such. Otherwise this type of knowledge would hardly rise above sense cognition. On the contrary, in these cases an effort is made to discover universal aspects in the individual phenomenon or to explain the individual as a concrete form of general or specific essences whose nature is laid down in universal propositions.

Thus we see that it belongs to the essence of science that the results are expressed in *universal* statements, i.e. laws or rules expressing that a definite species or genus is like this or ought to be like this. Of course, the principles also upon which a science is built—which may be borrowed from another science—are expressed in general propositions. The predicate of such general propositions, whether they serve as the starting point or formulate the result of the science in question, can be applied to the subordinates of the subject in a distributive way. This makes it possible to apply the knowledge obtained to new particular cases in a deductive way.

4. The Statements of Science Must be True or Probably True

The statements resulting from scientific research must be true and certain, at least if truth and certainty are within the reach of man with respect to the problem under consideration. It is to be noted that truth and certainty are not the same. A statement is *true* if *objectively* it is in conformity with reality, i.e. if it expresses the nature of things as they are independently of the consideration of the mind. A statement is called *certain* or *probable* for *subjective* reasons, if the mind adheres to the statement firmly, without any fear of error, or with a certain fear of being mistaken. With respect to the truth of a particular proposition, the mind can pass through a whole series of states, from a mere conjecture or suspicion through a more or less firmly held opinion to absolute certainty. Although in general a proposition will be true if we are subjectively certain of it, a subjective state of certainty with respect to a proposition that is objectively false is possible. In such a case we have to do with *false certainty*.

With respect to scientific statements, the ideal is that they be true. If in a particular case this ideal is not within reach, then the statements will have to be at least probably true.

5. Science is Concerned with the Essence, Foundation, Causes, and Finality of its Objects

Not every system of universal statements regarding a definite field of knowledge constitutes a science. It is not sufficient that the statements express things which are, their actual qualities, and their mutual interrelations. All this is necessary, but only as the starting point of further study, to give us an intellectual understanding of the foundation of these qualities, the nature and reason of their interconnection, and the causes of phenomena. The concept of cause will have to be taken in the broadest possible sense; hence it should not be restricted to efficient causes, but extended to final, material, and formal causes. The last two kinds of causes constitute in their inseparable union the essence of material things, the 'formed matter', while the final cause reveals itself in the inner finality of reality. In other words, the statements resulting from authentic scientific research will have to refer to the efficient causes of the phenomena, the essence of the things considered and therefore the foundation of their properties and activities, and finally their inner finality, i.e. that aspect of their essence which gives us an insight into the coordination of the component parts into one common result.

Because the statements of science refer to the specific or generic essences of things, a certain necessity will be implied in the expressed relationship of subject and predicate. The contingent element in the data of experience is removed from the cognitive content by means of intellectual abstraction. This process of intellectual abstraction, which gives the propositions their character of universality, is at the foundation of the necessity present in the connection between the subject and the predicate of the propositions. This necessity may be of a different nature in accordance with the subject matter to which it refers. We distinguish metaphysical, mathematical, physical, and moral necessity.

6. The Statements of Science Must be Logically Ordered

Although the very term 'system' more or less implies a logical order, nevertheless it is worth stressing that, as is commonly admitted by all, logical order is an essential requirement of science. The statements and conclusions concerning the essences and causes of the object in a definite field of knowledge may not be enumerated in an arbitrary way, but have to be arranged and classified according to a definite principle and following a definite method.

> Thus we understand why Newman held very strongly that
>
> The first step in intellectual training is to impress upon a boy's mind the idea of science, method, order, principle, and system; of rule and exception, of richness and harmony[1].
>
> Hence it is that critical scholarship is so important a discipline for him when he is leaving school for the University[1].

(Continued on Page 34)

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Science as a System

(Continued from Page 32)

Without critical training it is, indeed, impossible for anyone to do serious scientific work.

An essential element of science itself must be the methodical arrangement and classification of its statements, from the very starting point to the conclusions, in accordance with a logical order, such as that from the simple to the complicated, or from the known to the unknown. This order and classification are subject to variation according to the method chosen by the investigator with due attention for his purpose or the inner finality of science itself. Hence various methods of science can be distinguished, and are treated in the part of logic or philosophy that is called methodology.

7. Science Must Explain its Investigations and Arguments

To the six conditions enumerated above one more has to be added. Not any logically ordered collection of universal and true statements in a definite field of knowledge concerning the essences and causes of things constitutes a science or a scientific work. Science, as it is generally understood, requires that there be a connection between the statements, so as to make it possible to arrive at a judgment regarding their justification. Accordingly, we must require of a science that its problems and conclusions be connected by means of an explanation of the investigation, research, and especially the arguments and demonstrations that have led to its conclusions. The same is implied by St. Thomas when he describes science in the proper sense as knowledge acquired by means of demonstration.

8. Descriptive Definition of Science

According to the preceding considerations, in which we have made explicit what everyone accepts implicitly as the essential characteristics of science, we may now propose the following descriptive definition of science as a system:

Science is a logically ordered system of true, or at least probably true, and universal statements concerning the essences, foundations, causes and finality of objects in a definite field of knowledge, with reference to the investigations, arguments, and demonstrations upon which the conclusions are based.

9. Further Considerations

In a science which fulfills the above-mentioned descriptive definition it is possible to distinguish several constitutive elements or aspects.

1. An important element in the construction of a science is so-called *abstraction*.

2. The statements of a science have a character of *necessity*.

3. Every science has a definite area of study which it considers from a definite point of view.

4. Every science is based upon certain *foundations*. It has a certain *starting point* and usually also certain *presuppositions*.

5. The logical structure and character proper to sciences require that certain *methods* be followed.

6. The entire procedure of a science aims at investigating the objects in its field according to their essences, foundations, and causes. In this investigation it will often be necessary to start from a *hypothesis* concerning the probable foundations and causes. This hypothesis will have to serve as a basis of a *theory* in which the consequences of the hypothesis are further developed. The formation of a hypothesis is usually guided by certain analogous resemblances of the unknown phenomena to other, known, phenomena.

7. In one way or another, every science has to prove its conclusions. ●

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Health by Way of Mouth

(Continued from Page 13)

Vitamins, hormones, enzymes are formed by both the healthy plant and animal bodies, and therefore furnished in all natural foods. The refining of foods has led to the discoveries that they are essential nutrients. The histories about such deficiency diseases as beriberi, pellagra, rickets, scurvy, all representing vitamin deficiencies, are too well known to need explaining here. But since it is also known that not only vitamins, but hormones, and enzymes are synthesised by the plant and animal bodies either from so-called precursors that precede them, or from the mircoflora, it stands to reason that the human body can synthesize them also as long as the factors for doing so are present. Consequently every time a vitamin deficiency is shown present, an equally improtant deficiency of a mineral or microbe must also be looked for and if more than a temporary correction is desired must also be supplied. If the importance of minerals rather than that of vitamins had been discovered first, or if the discovery of the need for vitamins had simultaneously led to the discovery of their relationship to minerals or other precursors, much more might today be known about the inorganic bioelements as the basic activators, primers or catalysts in life processes. Their action may be compared with electrolites placed in a poor or run down battery to boost the voltage.

The healthy body requires an equilibrium in the way of the supply and demand for food metabolites and the removal of waste products. This means that every essential nutrient must be present in our daily food total. To the extent this is not the case they must be furnished as supplements, or through a change to foods of proper composition. And since man depends on a healthy microflora to make his own antibiotics, vitamins, enzymes, colonies of beneficial intestinal microorganisms must be supported. "Feed the Microflora! It will feed you," but do it correctly for beneficial effects. Omissions or excesses of nutrients in our foods, which are the materials for life processes, inevitably result in disorders in direct proportion to the violations of the laws of biology. Not only individual disorders but epidemics are caused by such violations, and nothing but an adequate supply of the essential elements that may be absent or deficient will correct them. ●

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Geophysical Year

(Continued from Page 18)

an understanding of this phenomenon could well aid us in obtaining a greater knowledge of the physical materials that make up the bulk of the earth's mass at great depths.

Meteorology. Of all geophysical subjects, that of most direct interest to every man is meteorology. Weather patterns are becoming of more and more importance to us, and we find that almost every phase of our material life depends to some extent on what the "weather" is doing.

To cope successfully with the weather, man needs reliable predictions. These in turn depend on a knowledge of the many and intricate processes that take place in the atmosphere and which result in the weather patterns that we experience.

The earth's atmosphere is the working fluid of an enormous heat engine driven by the sun. Large and small-scale circulation systems within the atmosphere transport heat from equatorial to polar regions. Another factor in this operation is the interactions that occur at the interface between atmosphere and land or sea. Certainly, an ice mass of the size that exists in the Antarctic must profoundly affect the weather in the southern hemisphere. The effects of the Antarctic may well be felt far north of the equator. One of our tasks during the IGY is to see to what extent this is so.

In addition to a carefully selected network of ground stations for surface observations, meteorological measurements will be taken to heights of 100,000 feet at many of the U. S. stations during the IGY. These observations should contribute to better knowledge of the dynamics of the atmosphere and to the delineation of circulation systems.

One very important project will be a measure of mass movements in the atmosphere between the tropics and polar regions. The meridional chains of stations already mentioned will play an important part in this study. The measurements will be made by certain stations selected to lie along lines of equal longitude, extending from pole to pole to the extent that land masses and islands permit. Such meridional lines are located at 70-80° W. longitude, 10° East and 140° East longitude.

For the first time in history, there will be enough stations in the Antarctic, properly distributed over that great land mass, to make possible the preparation of daily weather maps for that continent. The United States, at the invitation of CSAGI, will operate the Weather Control that will provide these maps. They will be of inestimable value for Antarctic flight and trail operations during the IGY.

From the meteorological and related observations taken during the IGY, we may expect to benefit eventually through improved and longer range weather forecasts, to say nothing of the increased understanding of weather processes that must precede such practical gains.

Finally, with the satellite it may be possible to get a measure of the "heat budget" of the earth as a whole; in other words, to measure the difference between the incoming radiation from the sun and the heat and light re-radiated by the earth and its atmosphere.

Oceanography. Oceanography is another geophysical discipline that is of vital interest and importance to the world's population. The vast sea areas that cover three-quarters of the earth's surface profoundly affect the world's weather. In addition, the seas have always been a prime source of food, a role that may well increase in importance as populations continue to grow.

Surface currents of the oceans have been mapped and studied for many years. We know their general features, but we need more data concerning their courses and their periodic variations, both long and short time, if we are to obtain a better understanding of the role they play in the weather. This understanding is needed particularly in the field of long-range weather forecasting.

Of the deep currents that exist in the ocean, practically nothing is known. They are probably related to large movements of water masses, and they certainly provide an important mechanism for the "turning over" of the oceans, a vital factor with respect to the total life that can exist in the sea. In addition to the importance of these deep currents, in terms of both weather and food, there is a third possible area for their utilization. This is in the disposal of radioactive wastes that will result from wider uses of nuclear power for peaceful purposes. The ocean deeps are ideal dumping grounds for such material if we can be certain that the waters thus exposed to contamination will not be brought up to shallower depths until these wastes have become harmless. At present we do not know whether the deep waters come to the surface in a matter of tens or of hundreds of years. Once some idea is obtained of this rate of flow, and provided the answer is favorable, we may have a practical solution to the radioactive-waste problem.

Glaciology. Glaciers are sensitive indicators of present-day trends in mean temperature as well as of changes during the past. Large ice masses, such as those encountered in the Antarctic and the Arctic have immediate effects on weather.

A careful study will be made of many of the glaciers of the world, not only to determine the relationships they have with existing climate, but also to provide, in many cases for the first time, datum planes that will be useful in future epochs for measuring long-time changes.

Seismology. The seismological program consists primarily of two parts, the first, the opportunity provided by expeditions and special stations in remote areas to measure the "seismicity" of those areas, and in some cases to obtain better locations of epicenters in the vicinity of those areas. The Antarctic and equatorial Pacific are examples. The second part of the program consists of a study of microseisms, those small tremors that provide the "background" noise on seismograms. These tremors are associated with such things as changes in barometric pressures, wave actions, and so on. A better understanding of their nature and origins may provide man a useful tool in detecting various disturbances at a distance. Microseisms have

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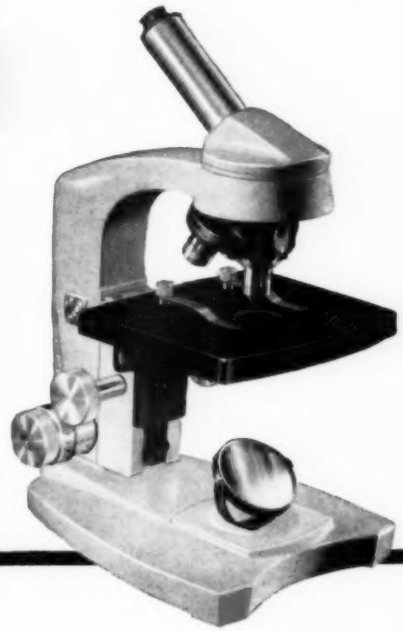

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already been used with some success in the detection of tropical hurricanes.

In studies of the ice caps of the Antarctic and Greenland, man-made earthquakes, produced by explosives, will provide seismic data for the determination of ice thicknesses.

Gravity. As in seismology, advantage will be taken of the opportunity to obtain gravity observations in normally inaccessible regions of the earth. A better system of tides between continents will be initiated during the IGY. Studies of earth tides, by the utilization of gravimeters of extremely high sensitivity, will also be considered.

Latitude and Longitude. A new photographic technique using the position of the moon in relation to the stars has made it possible to determine station positions with respect to the center of the earth with far greater accuracy than formerly. Taking advantage of this new development, 20 stations around the world will apply this technique during the IGY to obtain a better determination of the figure of the earth, and hence improved determinations of latitude and longitude.

The Earth Satellite

I have already referred briefly to the uses of rockets and satellites as tools for obtaining observations in the upper atmosphere and beyond. Although the scientific earth satellite has, because of its spectacular nature, been highly publicized, it is in fact, a logical next step to the high-altitude-research rocket. When the proposal to undertake the satellite project was first considered by the U. S. National Committee for the IGY, Professor Kaplan referred to it as the "Long Playing Rocket."

Time does not permit a detailed account of the satellite and of the many experiments that have been proposed for this unique vehicle. I shall therefore limit my remarks to a brief review of the principal physical features of the device and of its launching vehicle, and mention a few of the experiments that we hope to include in satellite flights.

The satellite will be a metallic sphere some 20 inches in diameter and its total weight will be 21.5 pounds. It will be placed on orbit by means of a three-stage-rocket vehicle, the first two stages using liquid fuels, and the third stage, a solid propellant. The total height of the launching vehicle will be 72 feet, and the maximum diameter, 45 inches. Its weight, fully fueled, will be approximately 11 tons. The first stage, developing a thrust of some 27,000 pounds, will start the system upward. Starting vertically, the nose will be gradually tipped over in the direction of the desired orbit. By the time the first-stage fuel is expended and the empty structure is jettisoned, the vehicle will be approximately 36 miles high. The empty first-stage case will land some 230 miles down range from the launching site. At this point, reached about two minutes after take-off, the speed will be from three to four thousand miles per hour.

The second-stage rocket will then take over, driving the vehicle to a velocity of about 11,000 miles per hour at an altitude of 130 miles when the fuel is used up. The nose cone will have been jettisoned early in this second stage of the flight. At this point the vehicle, still including the second and third stages and the satellite itself, will coast upward, inclining more and more toward the horizontal, until at approximately 300 miles altitude it will be tangent to a spherical surface concentric with the earth's surface and traveling at about half the orbit velocity. At this point the second-stage case will drop off and the third-stage rocket will fire, driving the satellite to its orbit speed of about 18,000 miles per hour.

Ideally a circular orbit about the center of the earth is desirable, but unavoidable inaccuracies in the launching phases will probably produce an elliptical orbit. We hope that this orbit will be such that perigee will not be less than 200 miles, with apogee not greater than 1500 miles.

If its orbit were circular and 200 miles above the earth's surface, the satellite would probably have a life of several weeks. At 300 miles, this life may be a year or more. At 100 miles, the satellite will probably last about an hour.

The planned orbit of the satellite will be inclined approximately 35° to the equator. Thus, the satellite will sweep out a band whose limits are about 35° north and 35° south latitude. In addition to providing data for an appreciable part of the upper atmosphere, the satellite's orbit will permit scientists of many countries to make observations of the flights.

During the time of one transit of the satellite around the earth—approximately one and a half hours—the earth will rotate about 22½° under the satellite, so that successive transits of the latter will be displaced some 22½° to the west. Through ground-observation stations, installed along a vertical line from Washington to Chile, a high probability of seeing the satellite on each transit is assured.

The satellite will be tracked both optically and electronically. Electronic tracking will be effected by means of a small transmitter, which will be installed in the sphere and which will also serve as a radio link for the transmission of data back to the earth. Since battery power must at present be depended on, and since the estimated life of these batteries will be only a matter of weeks, the latter part of an orbit, assuming the life of the satellite on orbit exceeds that of the batteries, will be tracked by optical methods only. These same considerations limit the duration of any experiments that require the transmission of data from the satellite.

I am sure you can appreciate the design problems that face the scientists and engineers who are planning the instrumentation that goes into the satellite. With a total weight of 21.5 pounds, about half goes into structure. The remainder must take care of power supply, sensing elements, modulators, transmitters and data-storage devices. Miniaturization and an extremely high degree of reliability are two of the exacting specifications that must be met.

The experiments to be undertaken with the satellite fall into two broad classes; those that do not require internal instrumentation, and those that do. The former

category includes measurements of the density of matter along the orbit, a measure of the mass distribution in the earth's crust, and the determination of the oblateness of the earth. All of these quantities may be determined by observing the velocity characteristics of the satellite on orbit. The gradual slowing down will be caused by the drag produced by the tenuous atmosphere, while perturbations will indicate variations in mass distribution as well as oblateness of the earth.

Instrumented experiments will include measurements of temperature within the satellite and on its surface, internal pressure to detect possible leaks produced by contacts with small meteors, solar ultraviolet radiation, cosmic rays, and possibly measurements of the geomagnetic field. Space and weight limitation will restrict the number of experiments that can be included in any one satellite body.

Regional Activities

In describing the international organization for the planning of the IGY, I mentioned the appointment of adjoint secretaries to deal with certain regions of the earth, such as the Antarctic, the Arctic, the Western Hemisphere, Eastern Europe, and South Africa. I am sure you will agree that the extent of the scientific programs that we have just reviewed will raise many problems of logistics support, including transportation and communications problems. Many of these can best be dealt with on a regional basis. There are also problems of coordination of the scientific programs of the different nations operating within the areas. The task of the adjoint secretaries is to deal with these problems to assure smooth working operation during the IGY.

The area that has received the greatest public attention is, of course, the Antarctic. This vast continent, almost the size of the United States and Canada combined, will by comparison with earlier years be a veritable beehive of scientific activity. Twelve nations are operating over 60 stations on the continent and in adjacent subantarctic islands. Some 40 of these stations are on the continent itself. The United States will operate five stations (Little America, Byrd, Weddell Sea, South Pole, Knox Coast), and will share the operation of a sixth with New Zealand (Cape Adare). The United States will maintain an Air Operating Facility at McMurdo Sound in the Ross Sea area as a base for the support of the U. S. program.

Actual operations began with an exploratory cruise of the Navy icebreaker, the USS ATKA, during the 1954-55 season. During the 1955-56 season, Operation Deep Freeze I built the main base at Little America and the McMurdo facility. It also brought in construction materials for the Byrd and South Pole stations and much of the supplies and a part of the scientific equipment. Wintering-over parties of construction personnel were ready to tackle the Byrd and South Pole stations as soon as the Antarctic spring permitted.

Operation Deep Freeze II, this year, has transported the group of scientists for the first year's operation, about 75 to winter-over and some 15 who will stay only through the present Antarctic summer. The materials for the Knox Coast and Weddell stations also went down this year, along with the balance of the scientific equipment.

Similar preparations are under way in other areas, although their greater accessibility obviates the need for the early construction and occupancy scheduled for the Antarctic.

World Data Centers

The "harvest" or, if you prefer, the raw material from all this scientific effort will be great masses of data in all the various fields of geophysics. The ultimate benefits that mankind will realize will depend on the rapidity and extent to which the research scientist has access to this mass of observations and can begin to make effective use of it.

In order to assure ready availability of all data, the CSAGI has recommended the establishment of three "World Data Centers." One of these centers will be in the United States, one in the USSR, and the third divided between Western Europe and Japan.

The following principles will govern the operation of these centers:

1. Each World Center will receive original copies of IGY data from countries that elect to use that particular center as the archives for their data. In general, it is anticipated that countries in the area of a given center will send their data to that center, although there may be exceptions. The important point is that all original IGY data will go to one of the three centers now planned.

2. Each center will immediately make copies for the other World Centers of the original data it receives and will supply these copies free of charge.

3. Any institution or individual may request copies of data from a World Center, which will be supplied at the cost of reproduction. Every effort will be made to keep such costs low.

Thus three complete sets of IGY data are planned, conveniently located to supply requests from scientists throughout the world.

Plans for the United States World Data Center are now being formulated. In all likelihood there will be a series of primary archives in the various disciplines, located at appropriate institutions and agencies, with a central coordination office for handling requests.

Conclusion

In summary, we have reviewed the origins of the International Geophysical Year, and have recognized the important contributions of its two antecedents, the First and Second Polar Years. We have looked at the international organization that has been set up to plan a world-wide coordinated scientific program. We have seen how the U. S. National Committee for the IGY under the National Academy of Sciences—National Research Council fulfills its responsibilities as a planning and directing organization at the national level. Some of the scientific projects to be undertaken have been described and a few of the areas in which we hope to obtain answers to basic questions have been cited. Finally, we have seen how the data that will be ob-

tained from the world-wide network of stations are to be handled so that all persons who wish to make use of them can obtain copies at nominal costs and with minimum delays.

You will, I believe, agree that this greatest of all scientific collaborative efforts should make contributions of inestimable value to our store of basic knowledge in the geophysical sciences and in related disciplines. No man can predict all of the practical benefits that may eventually stem from such increases, but our experiences with the two earlier periods of coordinated observations give us high hopes.

But the greatest benefit to be derived from the IGY may be the completely intangible but far-reaching implications of a great experience in international cooperation. When fifty-six nations collaborate harmoniously in the accomplishment of a common objective, there is surely a lesson to be learned from how this was achieved.

In his inaugural address, President Eisenhower stressed "our own deep involvement in the destiny of men everywhere" and declared that "These hopes we have helped to inspire, we can help to fulfill." Surely the scientists, who have demonstrated so well their ability to collaborate without regard to national boundaries on vast projects for the betterment of mankind, have a great contribution to make toward these important objectives. ●

Spectroscopy Society of Pittsburgh Aids Education

The Spectroscopy Society of Pittsburgh has made a grant of $500 to the Physics Department of Washington and Jefferson College, Washington, Pa., to purchase equipment to assist in teaching.

For additional assistance, especially at the secondary educational level, the Society has purchased a technical movie entitled "The Spectrograph" and deposited it in the Audio Visual Material Center, Chatham College, Pittsburgh 32, Pa. The 20-minute sound color film, prepared in England and made available through the British Information Service, is highly recommended for use with high school and college students in chemistry and physics. Both animation and actual scenes are used to explain what causes spectra and how spectroscopy is used for analysis in many fields of research and control. Over 2300 science teachers in the tri-state area have been advised of its availability at no cost except a nominal film-servicing fee of $1.50. Persons interested in its use should contact the Center at Chatham College.

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PART ONE: SCIENCE IN GENERAL.

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You Can Depend on the GENATRON

● THE MODERN ELECTROSTATIC GENERATOR

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch —whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts — or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old fashioned static machine!

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established **directly upon the discharge terminal.** The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the CamboscO Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer service of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an end'ess band of pure, live latex — a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

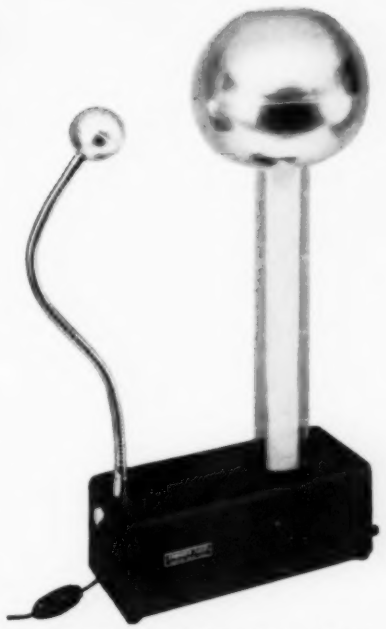
DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

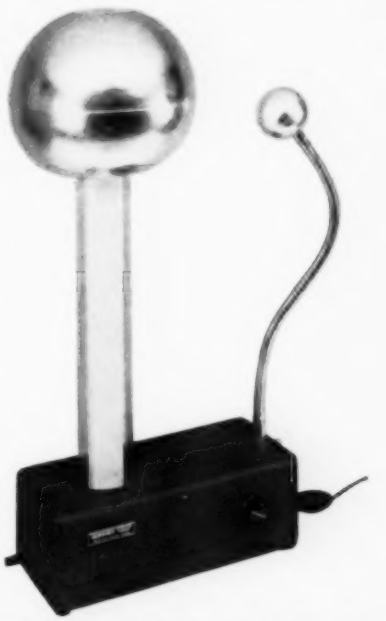
PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.



GENATRON, With Motor Drive

Operates on 110-volt A.C. or 110-volt D.C. Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

No. 61-705 - - - - $98.75



GENATRON, With Speed Control

Includes (in addition to equipment itemized above under No. 61-705) a built-in Rheostat, to facilitate demonstrations requiring less than the maximum output.

No. 61-708 - - - - $109.00

No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708. **$3.00**

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